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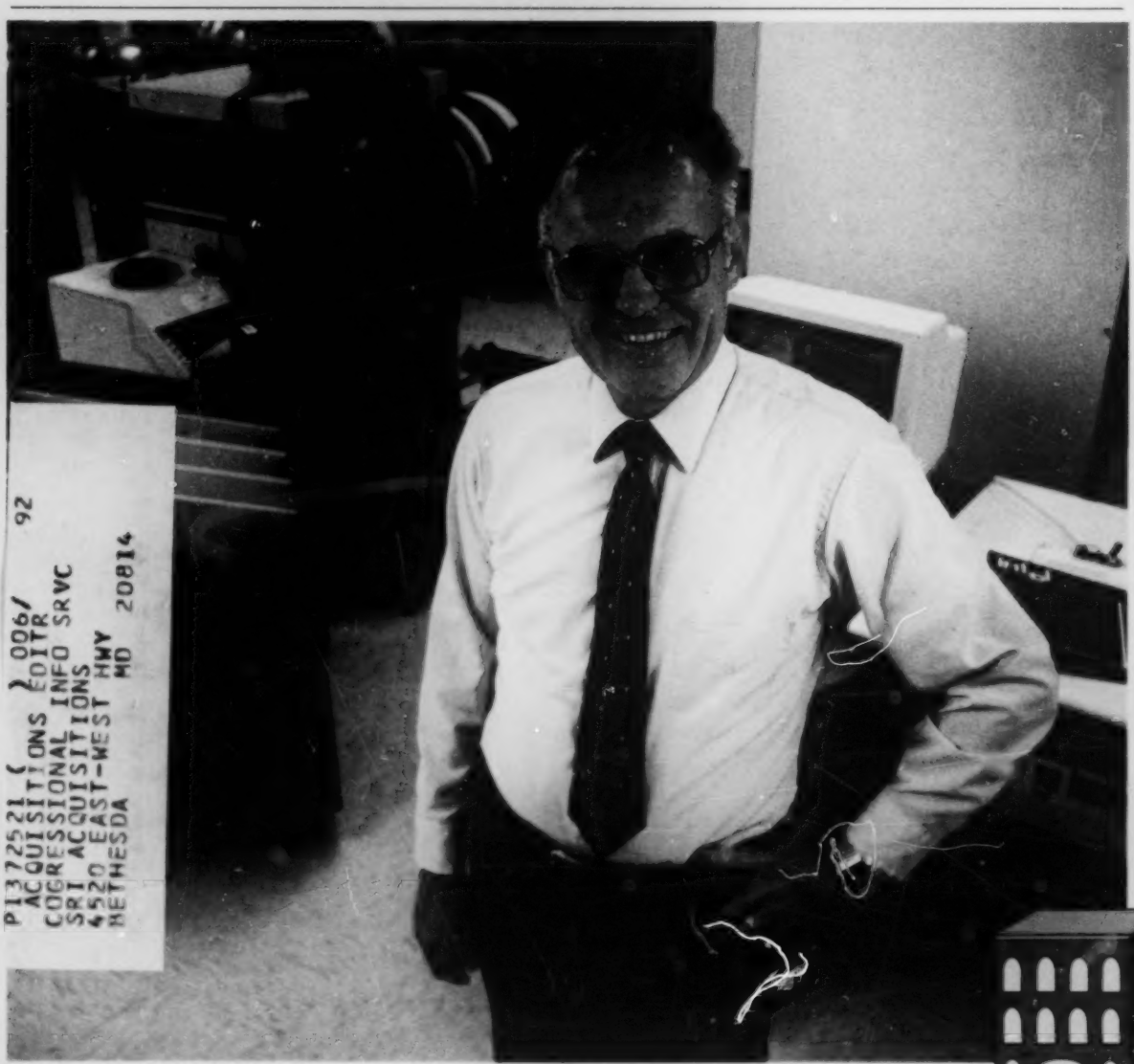

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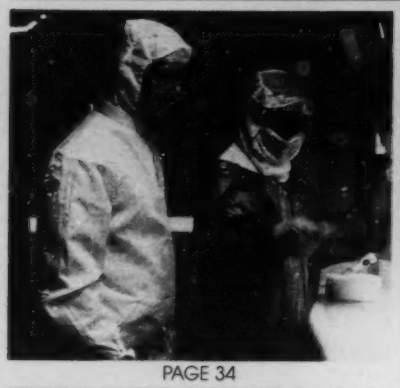
U.S. PLANT SITE DIRECTORY

Electronic Business

VOL. 13, NO. 22 NOVEMBER 15, 1987

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES



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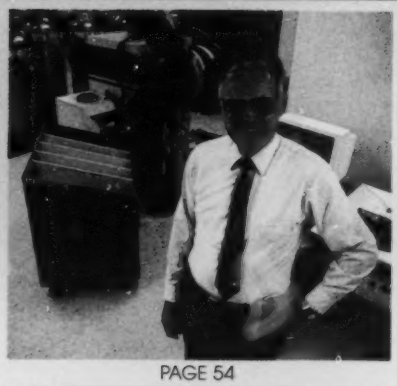

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BPA ABP

Computer production expected to accelerate in the new year

Evidence is accumulating that computers are now a cyclical industry, just like other capital goods

Since turning up in the last quarter of 1986, industrial production of computers and office equipment has advanced steadily through the first three quarters of 1987. Production is expected to accelerate through 1988, according to Cahners Economics. Such momentum will be welcome news for the second-tier players who've continued to struggle even as the likes of Compaq Computer Corp., Digital Equipment Corp. and NCR Corp. have shown exceptional revenue and earnings growth in recent quarters.

According to Marc Shulman, Salomon Brothers Inc. analyst, computer manufacturers and their electronic component suppliers could enjoy a boom market in 1988. Shulman bases his enthusiasm on the convergence of three macroeconomic indicators. For the first time since early 1984, all three — corporate profits, industrial production and capital goods orders — are rising. Pretax corporate profits rose by 19% in the second quarter. And between May and July, industrial production rose at an annualized rate of 7.5%. Orders for non-defense capital goods surged by 32.1% during the same period. Shulman foresees an explosion in equipment sales that will extend the 1987 recovery for their component suppliers as well.

If the boom materializes, it may simply be further confirmation that computers have become more of a traditional cyclical capital goods industry. In contrast with pure growth industries that defy broader economic cycles, capital goods industries typically prosper during the latter stages of business recoveries. During this period, companies begin to strain existing capacity and have sufficient cash to invest in new plant and equipment.

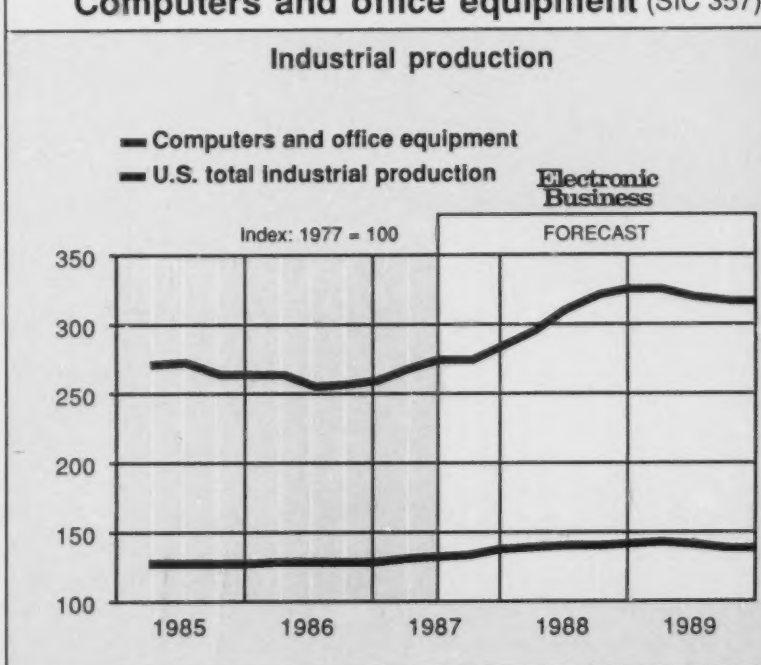
Companies such as Data General Corp. and Control Data Corp. would certainly welcome a cyclical upturn. IBM, which saw little revenue growth in the first six months of this year (versus the same period in 1986), could be the chief beneficiary of a capital spending boom, especially if mainframes return to customer shopping lists. But for some market leaders, a revival in capital spending would represent the extension — not the inception — of very good times.

Apple Computer Inc., for example, has been enjoying quarterly revenue gains of 30% or more over the past year. NCR has forecast record revenue and earnings for all of 1987. Earnings of Amdahl Corp. in fiscal 1987 are nearly triple those of 1986. DEC just keeps rumbling along, closing in on the $10 billion revenue checkpoint in its fiscal year ended June 30. Compaq, Tandem Computers Inc. and Sun Microsystems Inc. are all likely to grow in excess of 25% on their way to record revenue and earnings performances. But others — for example, Data General, Control Data and Wang Laboratories Inc. — will need a macroeconomic boost to recover dissipated momentum.

Data from Cahners Economics offers these firms some encouragement. Bookings of new business for the first seven months of 1987 are running almost 6% ahead of the same period last year. Backlogs, at a seasonally adjusted $19.2 billion, were at their highest level since the end of 1985. Except for such overly-contested market sectors as engineering workstations and minisupercomputers, prices have been fairly firm, according to industry analysts. With export business still strong in Europe and signs of new life in the Far East, the expected rise in U.S. capital spending could provide the rising tide to lift all ships.

NORM ALSTER

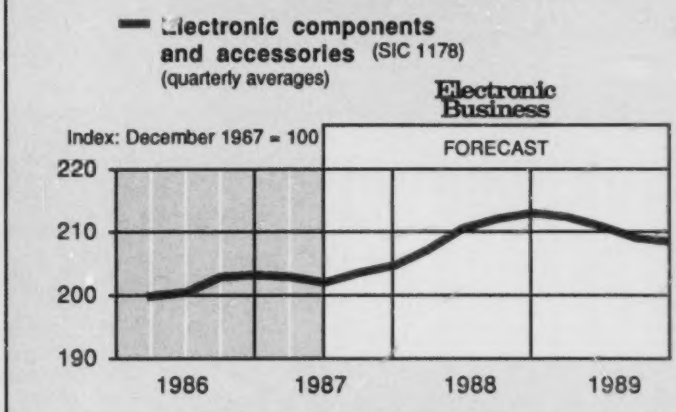
Computers and office equipment (SIC 357)



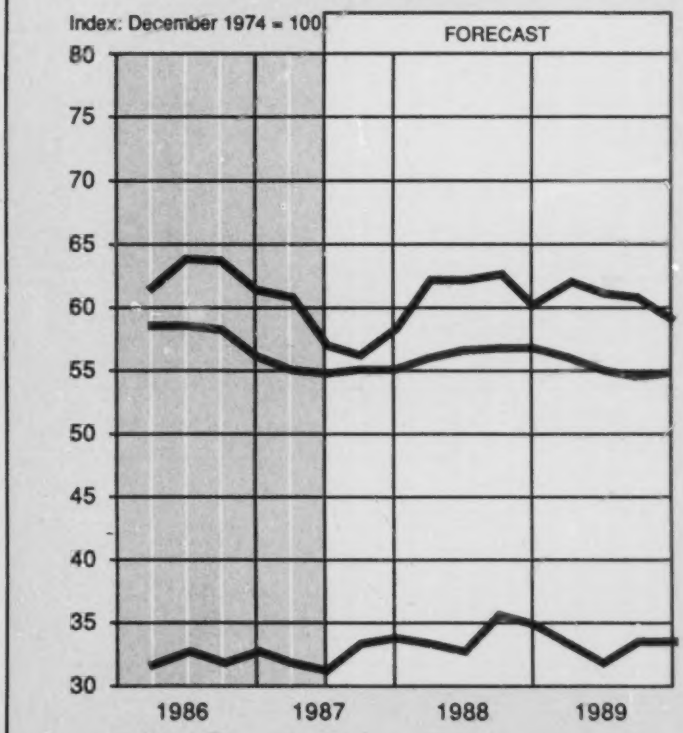
Historical data: Federal Reserve Board; Forecast: Cahners Economics

Producer price indexes

Electronic components



Passive components



Historical data: Bureau of Labor Statistics; Forecast: Cahners Economics

Electronic components & accessories
Producer prices for electronic components and accessories fell 0.4% in the second quarter of 1987 but appear to have bounced back 1% in the third quarter. Higher prices are coming from capacitors, resistors, semiconductors and especially connectors. Integrated circuits manufacturers, on the other hand, have been hard pressed to impose price increases. As the three examples below dramatize, most IC prices are much weaker today than a year ago. The next 12 months will see a change in these circumstances as higher demand forces all component prices up.

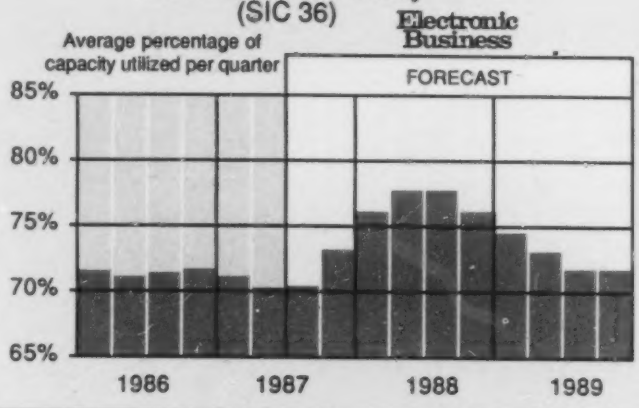
Digital bipolar ICs
According to the U.S. Bureau of Labor Statistics, prices of digital bipolar ICs fell 5.4% in the second quarter and appeared headed for another 1.9% decline in the third quarter. These prices are 10% and 11% below the year-ago levels. Prices are expected to fall 7.2% by year-end, and then rebound 6.2% next year. Leadtime information gathered by *Electronics Purchasing*, ELECTRONIC BUSINESS' sister publication, shows the supply of digital ICs is already tightening. Rising leadtimes, which indicate buyers are waiting longer to receive their orders, put upward pressure on prices.

Digital MOS ICs
Producer prices of digital MOS ICs also fell in the second quarter by 2.5%, leaving prices 5.5% below their year-ago level. But the turnaround in these product prices has already begun. Early evidence for the third quarter indicates prices jumped 7.7%, so by the end of 1987 prices will have actually risen 0.7% above 1986 prices. In 1988, prices are expected to surge 4.5%, then drop 3.1% in 1989. Growing demand for logic prices is leading to tighter supply conditions and firming prices. These Labor Department statistics are a useful indicator of product price trends as long as list prices are an accurate indication of the actual transaction price.

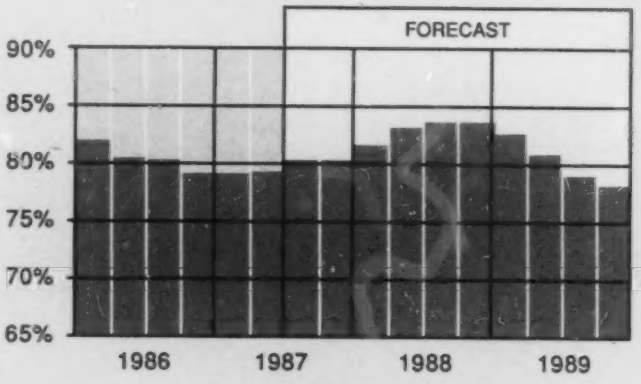
Linear ICs
After falling 1% in the second quarter, prices of linear ICs rose an estimated 1% in the third quarter. By the end of this year, prices will still be 5.4% below 1986. Demand for linear ICs is not expected to be as strong as for other devices over the next year, keeping 1988 price increases below the 3% threshold. Leadtimes for linear ICs ratcheted upward from a low of five weeks in October 1986 to nearly eight and one-half weeks last summer. But leadtimes will not rise much above 12 weeks next year, which is another indication of only modest price rises to come.

Plant utilization

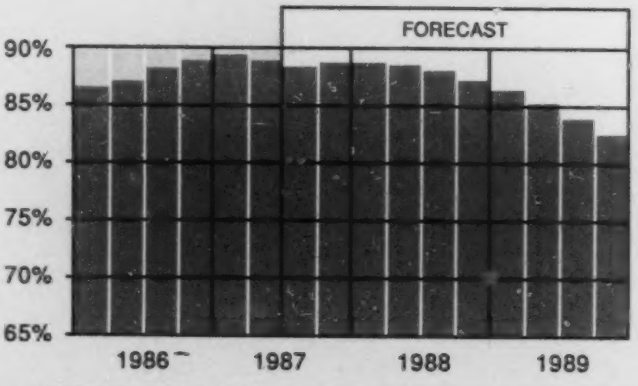
Electrical machinery (SIC 36)



Instruments (SIC 38)



Aerospace (SIC 37)



Historical data: Federal Reserve Board; Forecast: Cahners Economics

Electrical machinery

Manufacturers of electrical and electronic machinery operated at an average 70.3% of capacity during the April through June period, marking the second straight quarter of decline in utilization. Early reports for the third quarter show capacity utilization sticking at about that rate, the lowest level since the first quarter of 1983. However, the major segments within electrical machinery, most notably electronic components and communication equipment, recently have enjoyed healthy increases in new orders, and backlogs are on a slow rise. Operating rates should reverse their downward trend shortly and move up into the 73% to 78% range in 1988, but drop 3% to 6% in 1989.

Instruments

The factory operating rate of the instruments industry advanced slightly in the second quarter to 79.4% from the first quarter's 79.2% level. Estimates for the third quarter indicate rates are edging above the 80% mark. This upward swing is expected to continue. Orders and shipments for this industry are up from their year-ago levels and growth is expected to be strong for 1988. Anticipated increases in business investment, particularly equipment spending, will be a positive influence on production in this industry. Operating rates are expected to increase another 3% to 4% for next year, reaching their highest levels since the end of 1984. Utilization will fall off again about 5% in 1989.

Aerospace

Capacity utilization for aerospace manufacturers averaged close to 89% for the second quarter of 1987, about the same level as the prior two quarterly periods. Production in this industry shows continuing signs of softening due to the slowdown of defense spending. Although order backlogs are at high levels, new orders are not growing as quickly as in the past. This will exert downward pressure on the historically high operating rates the industry was experiencing in late 1986 and early 1987. Capacity utilization will decline over the next two years to the lowest levels since the beginning of 1985.

MATERIALS

Chip makers' choice: Clean up now or pay later

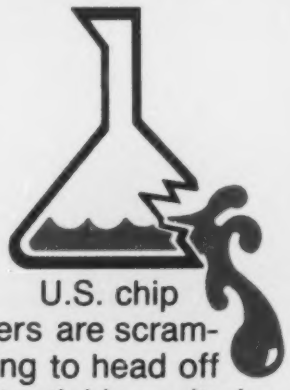
Health and safety issues may soon be a top priority in the U.S. semiconductor industry

The cost of doing business in the semiconductor industry may be going up again, but not because of Japanese competition or the falling dollar. Instead, health and safety issues in the manufacturing areas are coming to the forefront now, as watchdog groups and opponents of toxic chemicals band together to challenge the industry's "clean" status.

Once thought of as a very clean and injury-free industry, the semiconductor realm has come under attack in recent years, first from environmental groups alerting the public to the dangers of toxic chemicals polluting groundwater, and most recently from industry employees themselves, who are fearful of the chemicals they are exposed to in the workplace.

As a result, U.S. semiconductor companies are scrambling to head off potential lawsuits and workman's compensation actions by employees who claim that their health has been impaired on the job. How much are semiconductor manufacturers spending on internal safety programs? Based on interviews with more than a half dozen manufacturers, ELECTRONIC BUSINESS estimates that semiconductor companies spent roughly 1% to 2% of total revenue on in-house educational programs, safety engineers' salaries and other non-capital-equipment costs related to employee health and safety. If the total production of semiconductors in North America for both merchant and captive operations was $16.8 billion this year, as Integrated Circuit Engineering Corp. suggests, then the industry spent between $168 million and $336 million on health and safety this year.

Some industry officials suggest that this may be more than enough money to cover the cost of current health concerns. The Semiconductor Industry Association (SIA), for example, points out that the rate of illness and injury in the semiconductor industry is less than half that of other manufacturing sectors — 4.1 cases of illness and injury per 100 employees in 1984, compared with a 10.6 per 100 rate for manufacturing overall. And Richard Bolman, health, risk and safety manager for semiconductor manufacturer Siliconix Inc. says, unequivocally, that "the fab is *not* a dangerous place to work. There is just as much exposure, or more, to chemicals in your home than in the fab."



U.S. chip makers are scrambling to head off potential lawsuits by employees claiming that their health has been impaired on the job

But everyone agrees that worker safety should be a top corporate concern at every U.S. semiconductor company.

The DEC study

Safety, of course, is not a new issue in the industry. Five years ago, the National Institute of Occupational Safety and Health acknowledged in a report the link between glycol ethers, which are widely used as solvents throughout the industry, and reproductive damage in male and female test animals. As a result, the Environmental Protection Agency promptly requested that the Occupational Health and Safety Administration (OSHA) more strictly regulate worker exposure to these chemicals.

Concern was heightened, however, after widespread news reports of a study last year of the Digital Equipment Corp.'s LSI semiconductor facility in Hudson, Mass., by researchers at the University of Massachusetts School of Public Health. The final version of the controversial UMass report has not yet been published, but researchers said that preliminary findings indicate that women workers at the plant, which builds custom chips for DEC's MicroVAX computer series, have experienced double the average number of miscarriages of women nationally.

The report's impact on the semiconductor industry, which employs 75,000 production workers in the United States alone, has been far-reaching and profound. In the wake of the report, AT&T reportedly barred all women of childbearing years from working on its fab lines; other firms too, such as Fairchild Semiconductor Corp., have excluded pregnant women from at least one site. And most companies now offer women the option of transferring out of fab facilities and into other areas of the company, if they so desire.

Trade groups in the industry are also attacking the problem. The SIA in Cupertino, Calif., claims it has established the only industry-sponsored occupational injury and illness surveillance system in operation in the United States. And Sematech, a government-sponsored consortium investigating new technologies in semiconductor production equipment, reports it has been holding a series of closed-door meetings on health and safety issues in the industry. Likewise, the packaging group at the Austin, Texas-based Microelectronics

Computer and Technology Corp. is also doing research the subject.

Not to be outdone, the federal government has also gotten into the act. Former U.S. Labor Secretary William Brock, prior to the announcement of his resignation from that post in mid-October, asked OSHA to look into possible hazards for workers involved in chip making. And there is now health and safety legislation pending in the U.S. House of Representatives that could also affect the situation.

While some industry officials warn that watchdog groups are making a mountain out of a molehill, there is at least one significant example of employees who believe that they have been injured by exposure to chemicals used to manufacture printed circuit boards. That industry uses many of the same chemicals as the semiconductor industry, experts say. One hundred fifteen workers of the former GTE Communications Systems Co.'s printed circuit board plant in Albuquerque, N.M., sued GTE: the case was settled out of court earlier this year. Sources estimate the total settlement was in excess of $3 million. These same 115 people, along with 85 other fab workers, also have filed product liability suits against more than a half dozen chemical companies.

Ticking away in the background, industry officials realize, is a potential timebomb in legal proceedings, if women workers or future generations of children claim, either rightly or wrongly, that birth defects were caused by corporate negligence in the semiconductor industry. Notes Meta Mendel-Reyes, director of the Santa Clara Center for Occupational Safety and Health, a watchdog group, problems with toxic chemicals could prove to be extremely costly to employers "if deformed children start suing."

But those are only the long-term problems. In the short term, chip makers also face possible litigation stemming from what has become widely known in the industry as "exclusionary" policies. Some women workers, for example, claim that manadatory, or even voluntary, exclusion from semiconductor production lines is discriminatory because fab work is often one of the higher paid blue-collar jobs in the company.

Jeanne Patterson, a former senior operator at Siliconix, for example, was denied disability insurance after her doctor advised her not to return to her job when she became pregnant with her second child. She claims that exclusionary policies at her company and potential hazards in semiconductor manufacturing, "make me choose between having a family and having a job." Although Siliconix claims that its policy is to offer a transfer to women who don't want to work around chemicals to other jobs at equivalent pay outside the fab, Patterson took her disability case to the California Supreme Court, and won. She says she is currently planning to sue Siliconix for back wages as well.

RICHARD BOLMAN, Siliconix's health and safety manager is unequivocal: "The fab is *not* a dangerous place to work"

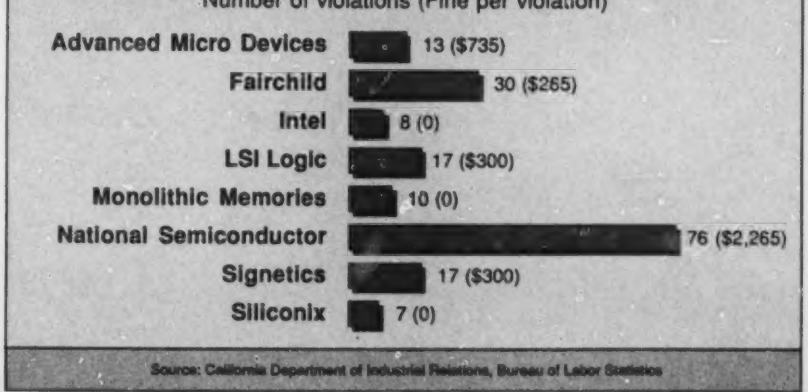
Unfortunately for the industry, Patterson's may not be an isolated case. ELECTRONIC BUSINESS has learned, for example, that the American Civil Liberties Union (ACLU) is considering suing a variety of organizations over the issue of exclusionary policies, including AT&T, DEC and the SIA.

"The [semiconductor] companies are being very close-mouthed on particular personnel policies," says Joan Bertin, associate director of the ACLU Foundation's Women's Rights Project, one of the 40 consumer, women's rights and health groups which have formed a coalition to pressure the semiconductor industry to protect workers' rights. "But if things don't proceed well, we'll have to think about litigation."

Not surprisingly, many chip makers are now taking steps to make their fab areas safer. At Signetics Corp., for example, the company allocates about 1.5% to 2% of annual sales for safety programs, and that does not include capital expenditures. And despite competitive pressures, Signetics claims its policy is to put safety measures above everything else, according to health and safety director Lou Yakubek. By the same token, Siliconix says it spent about $1.5 million last year on health and safety. And, although Intel Corp. declines to give a total figure for expenditures last year, safety manager Craig Modahl says that his company probably spent $1 million alone on rubber gloves.

DEC, too, claims it maintains

Occupational safety violations by semiconductor manufacturers in Alameda and Santa Clara County, Calif. — January 1979 - June 1987



Source: California Department of Industrial Relations, Bureau of Labor Statistics

MIKE VAUDEREIL, National Semi's safety man, says National is planning a switch to less toxic photoresist chemicals

some of the most stringent cleanroom standards in the industry. The Maynard, Mass., minicomputer company employs what could be the largest dedicated safety force in the semiconductor industry — 16 safety engineers and technicians out of a total semiconductor production workforce of 500. In addition, despite the complaints in the UMass study about alleged health hazards at the firm, DEC employs continuous gas and chemical monitoring systems, and maintains its own computer-based worker-exposure tracking system.

IBM, which operates the largest captive semiconductor business in the country, also operates state-of-the-art monitoring and control systems in its fab areas. Like DEC, IBM has set acceptable worker exposure standards above those required by the OSHA.

Additionally, as a result of the UMass study findings, IBM advised employees in May that it would conduct its own worker-safety study under Dr. Morton Corn of Johns Hopkins University. Actual data collection is expected to begin sometime during the first quarter of 1988, but the corporation has already notified production workers that it sees no reasons for concern. Since its inital announcement in May, a handful of IBM workers requested and received temporary transfers from the fab lines.

Meanwhile, other companies are substituting less toxic chemicals for toxic chemicals, lessening the concentration of the chemicals used, or substituting liquids or solids for toxic gases such as phosphine or arsine.

However, all of these changes cost money. "Don't let the chemical companies fool you," Intel Corp. health and safety manager Craig Modahl says. "It takes a lot of effort and time to switch chemicals."

Intel, which is currently switching from arsine to arsenic, also may switch from hydrotetrachlorine (used in metal etching) to chlorine, Modahl says. "That was done just from a safety standpoint. Hydrotetrachlorine is not a chemical you want to be using."

INTEL HEALTH and safety chief Craig Modahl: "It takes a lot of effort and time to switch chemicals"

Another area of concern is solvents such as glycol ethers, the key ingredient in the photoresist process, which is itself a vital part of process manufacturing. Any chemical change in this area would likely also require a process change, according to Gary Amstutz, technology director for KTI Chemicals, a subsidiary of Union Carbide Corp. And process changes are often very expensive. "There is no direct replacement [of one chemical for another]," Amstutz says, "because with different chemicals, there are performance changes, and that is very important because of the end-

Washington watch: S. 79; H.R. 162

This fall, the full Senate and House are expected to take up the High Risk Occupational Disease Notification and Prevention Act of 1987, or Senate bill 79; House of Representatives bill 162.

The bills advocate the establishment of a national panel of health experts to determine which chemicals are hazardous substances; and then to alert workers to the dangers of exposure. The bills significantly extend rights to workers beyond those accorded them by the Federal Health Hazard Communication Standard — the national "right to know" initiative, which requires employers to tell employees about potentially toxic substances and possible consequences of working with them.

The High Risk Notification bills are opposed by the National Association of Manufacturers and various associations representing small businesses. They claim the bills could result in extensive litigation and force them out of business.

But many big companies, including AT&T, Digital Equipment Corp. and IBM, are behind the legislation, and the word coming from many Washington insiders is that passage of the bills is virtually assured.

Some watchdog groups, however, claim that the current compromise versions of the bills are much weaker than when they were first introduced. Initially, the legislation would have allowed the results of studies performed on animals to be used as proof of possible toxicity of various chemicals. Now, human studies only are admissible as evidence. The bills also make no mention of exclusionary employment policies. □

Tim Davis

use application."

In addition, it sometimes takes a long time to incorporate changes into the production process. Some experts say a change in chemicals can cost a chip maker as much as four to six weeks in production. Notes Mike Vaudereil, safety manager at National Semiconductor Corp., National is now planning to switch to less toxic photoresist chemicals, but the evaluation process alone could take from six months to a year. Restructuring production lines is also a very labor-intensive operation, he says, and can only occur at National in one fab area at this time.

In fact, according to AZ Photoresist Products, a subsidiary of Hoechst AG, not very many semiconductor companies have switched over to less-toxic chemicals, despite some important technological advances in the field. Although several semiconductor companies are currently evaluating safer products, most customers are also concerned with higher performance, according to Richard Timmins, director of the chemical supplier. Safety is usually only one of several considerations.

Intel, for example, has not yet switched from glycol ethers, although the company is currently evaluating the switch. According to safety manager Modahl, it's important to make sure that a switch is a good substitute, not just an expedient one. Intially at least, some of the substitute glycol ethers produced by chemical companies were really no safer than the products they were intended to replace, Modahl claims.

> The impact of the UMass report on the semiconductor industry has been far-reaching and profound

Nevertheless, the industry appears to be serious about evaluating safer chemicals. Virtually all of the companies in the industry have someone in the firm looking at substitute materials. And Texas Instruments Inc. has even set up a separate group to study the long-term implications of a chemical switch.

Most semiconductor companies, however, do appear to be spending money on improving worker safety through education. And most firms routinely offer workshops, workbooks and video tapes on health and safety issues. Everyone at TI, including non-fab workers, goes through a basic training program in chemicals. In addition, fab workers receive specific training in their area of expertise.

Because a large percentage of fab line employees are typically workers whose first language is not English, training programs must frequently be tailored to meet their needs. Often, companies try to accommodate non-English speakers with increased use of graphics and pictures in their workbooks. Some companies, like National, have even experimented with conducting training programs in several languages.

Concerns linger

But some watchdog groups claim that the industry is dragging its feet. Leonard Siegel of the Pacific Studies Center in Mountain View, Calif., claims that the industry should be spending more money on research. "The cost of not doing it [making fabs safer] is potentially enormous," Siegel says. "Look just at what companies in this Valley paid to clean up toxic spills — $100 million."

"Health and safety issues in the

In search of the perfect study

One of the biggest problems in coping with health and safety issues in the semiconductor industry is the lack of hard evidence linking chemical exposure to specific health problems.

There are several reasons for this. First the industry is relatively young, and many chemicals have not been on the market long enough to support studies on their long-term effects. Second, there have been very few studies done in the industry, and none widespread enough to draw any significant conclusions. Third, different chemicals have different responses. Possible cancer-causing chemicals, for example, could conceivably cause cancer after just one exposure; other chemicals have a threshold over which they do damage.

The Digital Equipment Corp. study is a case in point. According to a number of doctors and industrial hygienists, sample size of the study is too small to be considered statistically valid — or more important, perhaps to show a link between miscarriages and chemical handling. On the other hand, proponents of the study say that glycol ethers, which were singled out by researchers at University of Massachusetts School of Public Health, have been cited by OSHA as early as 1984 for posing possible hazards to the reproductive system.

Either way, the UMass report suggests that more studies must be done. Concern over the issue has prompted the Santa Clara County Board of Supervisors to draft a resolution calling for the SIA, along with its members, to conduct an independent study of this issue in order to obtain valid results.

In December 1986, the SIA took the initial steps toward doing just that. Its Occupational Health Committee established a special task force (called the "Digital Task Force") to review the DEC study and present the SIA board with its findings. The task force, in its March report, found "significant deficiencies" in the DEC study. It also advocated that individual SIA dmembers undertake studies on their own. IBM and Texas Instruments Inc., among others, are known to be doing this.

The SIA also formed a special "Director-level Task Force on Worker Health" to work with SIA members that are interested in conducting a joint health study. In July, the SIA named a panel of five independent researchers charged with creating a protocol and developing a request for proposals for such a study.

If all goes as planned, the SIA study could begin as early as the first quarter of 1988. □

fabs are still a troublesome problem," adds Dr. Joseph R. LaDou says, a physician at the Peninsula Industrial Medical Clinic in San Jose. Worker's compensation data from the state of California still shows a disturbing incidence of systemic (chemical) poisonings in the semiconductor industry, he says — with an occupational illness rate of 36.5%, compared with 21.5% for all industries and 31.6% for other types of electronics manufacturing.

Moreover, the higher miscarriage rate cited in the DEC study is only one possible effect of chemicals used in semiconductor manufacturing. The study also showed that both men and women experienced a higher incidence of sore throats, dizziness, nausea and bad headaches while working in the fab.

Consequently, removing pregnant women from the fabs is not, in itself, an adequate solution. According to toxicologist Dr. Selina Bendix, president of Bendix Environmental Research, a consulting firm in San Francisco, what is unsafe for pregnant women most likely is unsafe for men. "What frustrates me the most," she says, "is that people don't realize that men's reproductive systems are often even more sensitive than women's, so moving women out of the fab is the wrong decision. What about the men? It has to be made safer for everyone."

> Ticking away is a potential timebomb in legal proceedings, if researchers are able to establish a positive link between chemical exposure and birth defects

Bendix also points out that damage from chemicals is often incurred in the first four to six weeks of pregnancy, before the women even know they are pregnant. Among men who have been exposed to glycol ethers, lowered sperm count and other testicular problems have been cited by some researchers. That has led some health experts to predict that fetuses can be damaged by just the male partner's exposure to chemicals.

VALERIE RICE and MARY JO FOLEY

COMPUTER-INTEGRATED MANUFACTURING

As DEC's manufacturing customers go, so goes DEC

From computer vendor to systems integrator: DEC is changing its approach to the factory floor

In the realm of computer-integrated manufacturing — where islands of automation are being tied together via networks and computers — manufacturers are in search of vendors that can provide the most far-reaching solutions to their complex problems.

One vendor anxious to meet all of its customers' demands is Digital Equipment Corp. This $8.4 billion Maynard, Massachusetts-based corporation already holds the largest market share in computers and peripherals used in CIM applications. In 1986, DEC held a 35% share of the $5.9 billion domestic market, according to research firm International Data Corp. (IDC), of Framingham, Mass. IBM came in second with 29.6% and Hewlett-Packard Co. was No. 3 with 9.1%.

But the race for the greatest installed base of hardware is giving way to a new contest. Now, the equipment giants — DEC, HP and IBM included — are vying to become masters of systems integration. DEC's ultimate ambition in the CIM marketplace is to provide systems integration for an entire corporation, says Donald Bell-Irving, marketing group manager of the Industrial Automation Systems group at DEC's Westborough, Mass., facility. Although such far-reaching solutions might sound a bit lofty, major U.S. manufacturers are considering just that.

Take the case of CIM user Motorola Inc. There, the key emphasis is, "aiming towards the computer integrated enterprise. Not just in the manufacturing area, but the entire enterprise," says Donald Walker, vice president and director of semiconductor automation at Motorola's Phoenix, Ariz., headquarters. But to get there, Walker says, the company had to start at the bottom, first finetuning each process and item of equipment before getting ready to begin integration.

Today, this $5.8 billion semiconductor giant has an advanced factory "prototype," which encompasses a fully automated, start-to-finish semiconductor assembly line. This Chandler, Ariz., pilot factory is used to demonstrate concepts in integrated manufacturing. Although Motorola could have completed this project in-house, Walker estimates it would have taken an estimated five years to do so. Instead, the company contracted with an outside consultant that had experience in computer integration projects and had hardware and software ready to go.

> DEC's networking capability is its "ace in the hole"
>
> Andrew Chatha of ARC

Vendor bias

Whether or not Motorola would consider turning to a DEC or IBM to provide such services is now moot. Walker has indicated that much of what was done in Chandler will be duplicated in Motorola factories worldwide, but will be done mostly in-house using application software contractors when necessary. Walker noted that he has "no bias for or against DEC or any other major computer vendor," regarding the use of their services as systems integrators. However, he voices possible concerns regarding vendor equipment bias and lack of flexibility. Motorola, in fact, insisted that its contractor change from the computer it was offering to a DEC system. In such situations, he adds, "a computer manufacturer wouldn't be able to do that. They'd be less flexible."

Whether or not this issue will present problems for DEC remains to be seen. DEC's Bell-Irving points out that his company is interested in business only where DEC systems can

play an important role. "You're probably not going to find us being successful competing against IBM," he says. "To integrate where products are all IBM doesn't make sense for us." Rather, he adds, DEC wants to leverage the expertise it has with its own computing systems and networks. But Bell-Irving also cautions against taking the simplistic view that the company's thrust in CIM is primarily to sell hardware. The No. 1 reason for offering computer systems integration, he says, is because "customers are asking for total solutions, and we view it as our role to provide products and services."

In order to do just that, DEC has been forced to do some rethinking, as well as reworking some old habits. "In the past, we relied very heavily on original equipment manufacturers to provide and sell solutions. We sold only the hardware," Bell-Irving notes. "Today, we are actively developing solutions with applications partners so that we can sell real business solutions. We are even going one step further, integrating our systems and networks with their application solutions."

DEC's alliances

Over the past three years, DEC has been building alliances with OEMs and applications software firms. Some of the most noteworthy include: ASK Computer Systems, which makes software for Manufacturing Resource Planning (MRP) applications; Biles and Associates, which makes real-time database software that detects process conditions such as temperature, pressures and flow rates; Consilium Associates, which makes software that runs thin film and other semiconductor operations; and, two giants in factory automation, GE Fanuc Automation N.A. and Honeywell Inc., two systems-marketing partners that will sell DEC's VAX computer systems and develop VAX interfaces to some of their own products.

DEC is interested in business only where DEC systems can play an important role

In addition to partnering efforts, DEC now has four Solution Integration Centers across the United States — in Georgia, Connecticut, Michigan and California. These offer what DEC calls its Manufacturing Systems Integration Service, or MS/IS.

The strategy of selling solutions with hardware is not exclusive to DEC. It's no secret that IBM and HP also covet systems control in the factory, and that they are fitting rivals to DEC. In fact, on the service side of the business, excluding hardware or software sales, the scales are tipped in IBM's favor. The domestic market vided by computer companies totaled $58 million last year, according to a report by research firm Automation Research Corp. (ARC), in Medfield, Mass. And IBM topped the heap with a 34.4% share, followed by DEC with a 25.8% share and HP with 12.4%.

IBM is also the clear leader in personal computers on the factory floor, says Andrew Chatha, president of ARC. And that presence is expected to expand. Once Big Blue ruggedizes its PS/2 computers, they will go head to head with DEC's MicroVAX small computer, predicts Chatha, who also estimates that "IBM will sell far more PS/2s than DEC will sell MicroVAXs."

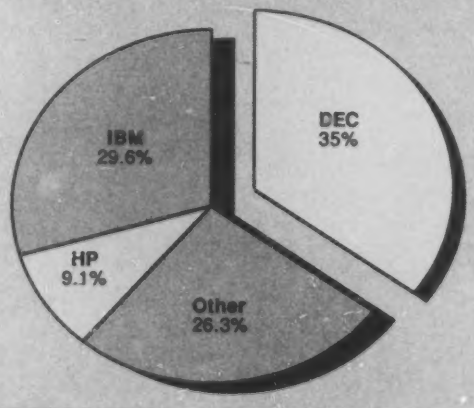
Although an installed base of boxes can be a great lever in winning CIM contracts, it is not the real key. The heart of CIM is integration, Chatha says, and DEC's networking capability is its "ace in the hole."

In the HP-versus-DEC confrontation, HP will have an uphill battle, says Irvin Krause, national partner for CIM at accountancy Coopers & Lybrand in Boston. In listing some HP strengths, Krause notes that HP does a lot of teaching and training, and opens its plants to let clients see how HP itself automates. And he explains that the company has well-entrenched niches where they are favored, such as in inspection, test and lab-type operations. "It will be interesting to see how HP defends its niches," he concludes.

CAROL SUBY

DEC dominates the market for computers and peripherals used in CIM applications...

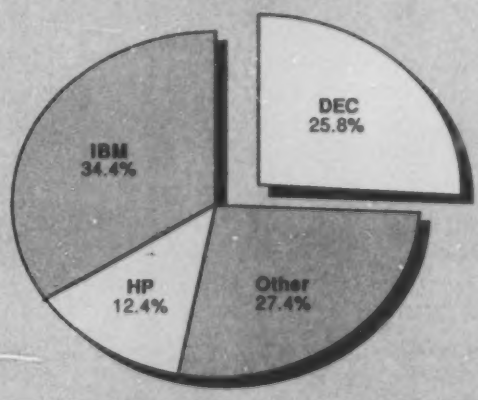
1986 shares of the $5.9 billion domestic market:



Source: IDC/CIMdata Inc.

...but trails Big Blue in systems-integration services:

1986 shares of the $58 million domestic market for services provided by computer vendors:



Source: Automation Research Corp.

CAD/CAM

CAD/CAM suppliers to the Navy: Send us a signal

A proposed multibillion-dollar purchase by the Navy could have effects far beyond its sheer size — if it proceeds

Early this year, the CAD/CAM industry was abuzz with talk of a planned multibillion-dollar Navy procurement. Potential vendors, drooling over what some said would be the single largest order ever for design automation software running on engineering workstations, were putting together infrastructures for bidding and flirting with potential partners. But now there is some question as to whether or not the procurement will get the go-ahead, which leaves CAD/CAM vendors puzzling over how to go after this potential prize.

Over the last 18 months, the Navy sent out to the industry two separate requests for information (RFI) to help it figure out how to automate its 40,000 engineers in computer-aided design, manufacturing and engineering. The second RFI ran to two volumes and 1,500 pages, and laid out a very ambitious plan for integrating everything from ship design to integrated-circuit design to documentation, all on tightly networked 32-bit Unix workstations. In February, some 50 vendors met at a Navy CAD users group, and speculation then was that a request for proposal (RFP) for bids would be out in midsummer.

None has emerged, and the latest expectation is that there will not be one until March, at the earliest.

> "It's going to be the largest thing coming out to the CAD/CAM industry next year"
>
> William Salter of Intergraph

When, or if, it comes out, it may be drastically different from the original plan. The original manager of the project, Capt. Joseph Callahan, then of the Navy Sea Systems Command, retired and has not been replaced. And the Navy says it won't talk until the RFP is out.

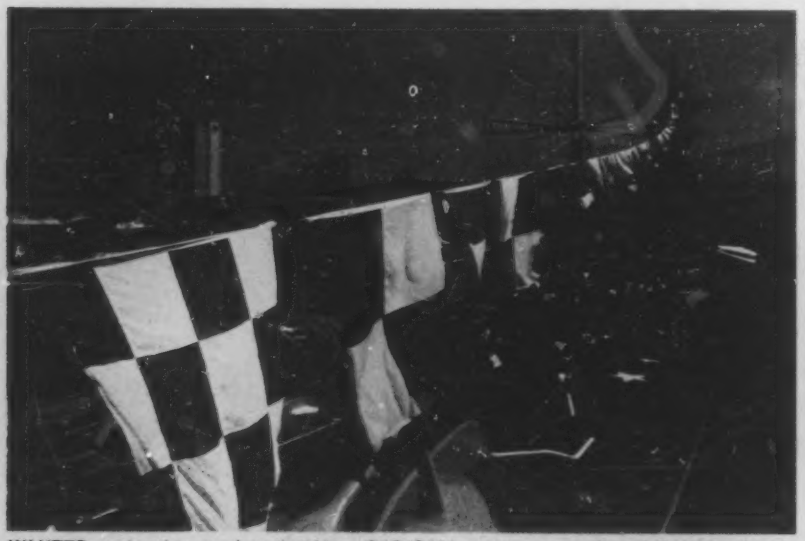
Who cares? Everybody

The award is important for two reasons. First, the procurement is big enough to tempt CAD/CAM vendors, workstation makers and even traditional military heavyweights. "It's going to be the largest thing coming out to the CAD/CAM industry next year," says William Salter, vice president for CAD/CAM supplier Intergraph Corp.'s federal business. He estimates that the Navy could buy $2 billion worth of systems over the next five years, including $150 million to $200 million in electronics design. "It's large enough that EDS and people like that — maybe even the Digitals of the world — would be interested," Salter says. Adds Steven Burrows, major accounts manager for CAE maker Mentor Graphics Corp.: "Various contractors will standardize on what the Navy buys. You could assume a total value three or four times over what the Navy purchases."

Second, and maybe more important to the CAD/CAM industry, is that the Navy is demanding networking and data transfer standards, some of which are still being developed by The Institute of Electrical and Electronics Engineers Inc. committees and others. And it wants to integrate what until now have been disparate design disciplines. "If it's successful, it will go a long way toward standardizing the CAD/CAM industry," Intergraph's Salter says. "It will force a number of the vendors to look a lot alike in products."

Even IBM says the Navy is "the biggest driver of standards," but that is a "good news, bad news" kind of proposition, according to Robert Tiel, director of marketing for electronics design in IBM's Information Systems Group. "It is a big opportunity, but the RFI is somewhat challenging," Tiel says. Matching up with what the Navy wants in the way of the Unix operating system "is pushing all the vendors, particularly us," he admits. But IBM is definitely interested — some of its "key accounts show a similarity to the Navy" in their demands, Tiel says.

If IBM wins the contract, according to Charles Foundyller of market researcher Daratech Inc., "Then all of CAD/CAM could go into one garden patch." Daratech ranks IBM No. 1 in the business already, with 25.5% of 1987 world sales of CAD/CAM equipment. Intergraph is second, with a 15.3% chunk of the $4.5 billion market. If IBM doesn't win, whoever does could get instant market share. "With things like the Navy contract,



WANTED: a signal to vendors that Navy CAD/CAM procurement will go full steam ahead

we could displace people," says Malcolm Davies, a vice president at Calma Co., the General Electric Co. CAD subsidiary which Daratech ranks a distant fourth.

To RFP or not to RFP

Industry observers theorize that a combination of internal squabbling in the Navy and grousing by potential suppliers may have already killed the plan. "The program on the table, as far as we're concerned, doesn't exist anymore," says Carol Bartz, vice president of the Federal Systems Division at workstation maker Sun Microsystems Inc. "The vendors just don't know what will happen."

The RFI was put together by Sea Systems Command, even though it calls for a five-part procurement by four other Systems Commands. "The other Commands may be saying, 'If it is over all five Commands, what is Sea Systems doing in charge of it?' " speculates Nina Lytton of industry watcher, The Yankee Group. Such "shilly-shallying" by the Navy might end up forcing the procurement up to the level of the Department of Defense, which would start the process all over again, she says. Lytton adds that Sea Systems did a "bang-up job" on the RFI.

Apparently, the Government Accounting Office agrees. Some vendors took a deep breath recently when the GAO announced it was looking at the procurement. The spending watchdog studied technical aspects of the proposal, an unusual step, and interviewed potential vendors to see if what the Navy wanted was feasible. Intergraph's Salter says his company was surveyed. One of the GAO's technical assessors, Kenneth Buckley, says he can't really disclose what the investigation showed. "The one thing I will say," Buckley says, "is that the Navy specifications are very well done. It is a visionary document."

Maybe too visionary. David Owens, director of marketing and business planning for Lockheed Corp.'s CAD subsidiary, Cadam Inc. says the Navy tried to convince Lockheed's Information Systems Group to make a bid for the whole package. "Lockheed actively hired consultants and spent two or three months taking a good hard look at it," Owens says. "They decided maybe the worst thing possible to do was win the Navy business, because it was a very blue-sky spec." Lockheed didn't want to get locked into the Navy's vision of the future of CAD. Cadam's point of view could be important, as its products are resold by IBM and 78% of IBM's CAD/CAM sales include Cadam equipment, by Owens' estimates.

Throwing weight

The analysts and some of the potential bidders hint that big hardware companies might be throwing a little weight around in Washington. A later RFP would allow Digital Equipment Corp., Hewlett-Packard Co. and IBM to firm up their workstation and Unix efforts. Daratech's Foundyller has an opinion on DEC's chances in any Navy competition: "The thing that kills DEC is the Unix requirement," he says. DEC's version of Unix costs its computers some performance when compared to its proprietary operating system, he adds.

> Maybe more important to the CAD/CAM industry is that the Navy is demanding networking and data transfer standards

Lytton, of The Yankee Group, also points out that the specs call for an "open" 32-bit bus. Data must be transferred across a bus for which statistics are published, and DEC's 32-bit bus is proprietary, she says. And much to IBM's chagrin, "the word mainframe is not mentioned in the entire RFI," Lytton adds.

Hewlett-Packard is arguably the furthest along in adopting industry standards, but HP CAE marketing manager Mark Tolliver says the RFI already accounts for "delayed deliverables" — products in the pipeline — that should come along naturally in the fast-paced workstation and CAD worlds. He specifically points to hardware pricing and advanced database manipulation as areas the Navy is willing to forgive a little on, for the time being.

But it all may come down to ships versus automation. "You know, a billion dollars is half an aircraft carrier," says Mentor's Burrows. One potential supplier, who prefers anonymity and used to work for the Navy, says, "Only one out of 10 admirals will be standing up for automation. All the others will be saying, 'I need ships, I need aircraft, I need facilities.' "

DAVID CARD

A proposed Navy contract could mean the biggest CAD/CAM deal ever

Estimated revenue for Navy CAD/CAM ($ millions)

	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993
Workstations	$32	$45	$65	$94	$135
Software	32	52	86	146	240
Peripherals	12	18	28	45	75
Service	11	18	33	63	113
Total	$87	$133	$212	$348	$563
Cumulative total	$87	$220	$432	$780	$1,343

FY = U.S. government fiscal year

Source: Dataquest Inc.

EUROPEAN ELECTRONICS

En garde, Uncle Sam! Europe is ganging up

Big Government failed to build a strong electronics base in Europe. Now let's see what the industry can do

By Jack Gee

Consolidation is the watchword this year for Europe's electronics companies. To withstand increasingly bitter international competition they are joining forces with rivals on their own continent and in the United States and Japan. Mergers, alliances and joint ventures are announced almost every week. These reflect new strategies by the old continent's manufacturers as they struggle to defend and expand market shares in components, computer systems and telecommunications.

"It's a crucial question of economic strength," says Pierre Braudé, an electronics industry consultant based in Paris. "Bigger companies with deeper pockets and wider product portfolios can survive better than their smaller brethren."

Edward M.A. Mier, director of market research firm Dataquest's European Telecommunications Industry Service in London, remarks: "With investment in a new public office switching system starting at $1 billion followed by ongoing annual expenditure of $1 million a year, there is only one way for European companies to achieve critical mass and economies of scale. That means mergers and partnerships."

Europe's electronics companies have come together before under government-sponsored research projects, such as the Esprit and Eureka programs. But tardy progress on such pan-European projects clearly is encouraging these participants to take matters into their own hands by letting market forces, not governments, dictate their success.

Bigger production and marketing units are being created against a backdrop of lackluster economic performance in the European countries. According to the Organization for Economic Cooperation and Development, (OECD) which groups together the Western world's 24 most prosperous nations, growth in Europe is unlikely to exceed 2% this year. This will be inadequate to make a dent in unemployment, which keeps 12% of the workforce idle.

OECD, based in Paris, points out that the U.S., with an increase of 33% in real economic growth over the past eight years, and Japan, with 17%, are constantly outpacing Europe's limping 12% growth. During this period, Europe has recorded virtually no net increase in jobs.

Consolidation is the watchword this year for Europe's electronics companies

While Britain, Italy, Spain and Portugal show respectable growth rates, they are achieving these from low base levels. Social and economic policies inherited from the early years after World War II are still smothering entrepreneurship and undermining market forces. Throughout most of Western Europe, politicians still lack the courage to sweep aside structural rigidities and cut Big Government down to size. And macro-economic policies among members of the 12-nation European Community — and most particularly in the linchpin economy of West Germany — remain excessively restrictive.

However, many European electronic companies are belatedly coming to grips with the realities of business life. Often, this apprenticeship is a hard school after decades of government protection which, while sheltering their businesses at home, has excluded them from foreign markets. Not surprisingly, Europe's high-tech success stories are to be found among companies such as Italy's Ing. C. Olivetti & Co. and West Germany's Nixdorf Computer AG, which have prospered without government support. Others, such as ICL Ltd., Britain's flagship computer maker, have largely shed their previous roles as cossetted "national champions." Today, they are proving they have the stamina to prosper in a competitive environment.

Nixdorf is one of the few European companies that prides itself on steering clear of the merger race. Chairman Klaus Luft, who took over the presidency after the sudden death of Heinz Nixdorf last year, has repeatedly denied that he would welcome a bigger partner in order to become a major foreign player in the U.S. market. Luft says: "Of course, Nixdorf could increase sales volume simply by buying brand names. However, we prefer to maintain our corporate culture and to train and hire more people of our own."

Europe's biggest electronics shakeup this year followed ITT's decision to withdraw from its far-flung, $6 million a year telecommunications equipment business. Control has now shifted to France's Compagnie Générale d'Electricité, which was returned to private ownership this summer after five years under state control. The telecom activities of ITT

Greg Couch

Late but in earnest: Europe's electronics industry is coming together to challenge Japanese and American dominance

and CGE have been pooled in a new company, Alcatel N.V., in which CGE has a 55% stake while ITT retains 37%. The remainder is owned by Belgian and French partners.

Georges Pebereau, a French electronics veteran who was chairman of CGE during the negotiations to create Alcatel, was determined to join forces with either ITT or ATT. He recalls: "I told Rand V. Araskog [ITT's chairman] it would be impossible for ITT and CGE to compete separately against AT&T, Siemens, Ericsson and the rest. We had to find a way to cooperate." To hedge his bets, Pebereau delivered the same message to AT&T.

At the end of the bargaining, the French government, as CGE's owner, ruled in favor of a partnership with ITT. "It is a very good deal for France," says Alain Madelin, the French Minister of Industry. That has yet to be proven. Meanwhile, the merger has completely redrawn the structure of the international telecommunications industry. It leaves Pierre Suard, the Frenchman who now heads CGE, addressing the same problems that daunted ITT. The Alcatel venture, with 30 subsidiaries operating in 79 countries and $13.4 billion in annual revenue projected for this year, ranks behind AT&T as the world's second-biggest telecom company. Worldwide sales and rental of AT&T's telecommunications equipment came to $16 billion in 1986.

The president of a major competitor says: "If CGE can rationalize ITT's operations, it will have powerful world presence. But it will be very difficult to make the merger work." Among the problems confronting Suard is how to restore the confidence of telephone operating companies in the trouble-ridden System 12 public office switch inherited from ITT. Dataquest's analyst, Mier, says: "ITT really had little choice. Without that merger, its telecom business would have [been in dire straits]."

ITT says it also intends to sell its 23.9% stake in Britain's STC Plc, the last relic of its European presence in telecom. However, ITT is waiting for

a good price. Daniel Weadock, ITT executive vice president and president of ITT-Europe, which is based in Brussels, Belgium, says: "Our STC holding isn't on the block with a for-sale sign."

ITT had planned to sell its STC holding to France's CGE with the rest of its telecom assets in Europe. But it dropped the idea when Lord Keith of Castleacre, the STC chairman, objected that CGE competed with STC in the telecommunications arena. STC, which is also looking for alliances, is expected to announce profit gains for 1987 and again in 1988. But the company is likely to encounter renewed difficulties as competition grows in the British market for the products of its core businesses: telecom products and the mainframe computers made by its subsidiary, ICL Ltd.

France's CGE and Britain's STC are not alone in scrambling to find international partners. STET SpA, a unit of the Italian state-owned conglomerate Istituto per la Ricostruzione Industriale, and Telefonica, Spain's state phone company, are preparing to pool their efforts in managing phone networks, introducing new technology and services, and developing telecom standards.

STET recently cleared a merger of Italtel SpA, its public office switching offshoot, with Telettra SpA, Fiat SpA's telecom unit. This joint venture, Telit, is not yet operating. But it is being courted by some of Europe's biggest telecom concerns, including West Germany's Siemens AG and Telefon AB L.M Ericsson of Sweden, which are also keen to become partners.

As a wind of change is blowing through Europe's hitherto highly regulated telecom business, Britain's fledgling carrier Mercury Communications Ltd. is seeking traffic agreements with firms in neighboring countries. Mercury, an offshoot of Cable & Wireless Plc, only recently began to compete at home with British Telecommunications Plc. Soon, under an arrangement with Italy, it intends to charge up to 17% less than British Telecom for traffic between the two countries. Gordon Owen, Mercury's managing director, has already established reciprocal arrangements with carriers in the Australia, Canada, Singapore and the United States.

Meanwhile, two British electronics giants, General Electric Co. (not related to GE in the U.S.) and The Plessey Co. announced recently that they intend to merge their telecommunications activities. The proposed 50-50 joint venture, which will start with nearly $1.9 billion in revenue, will handle public switching, private switching, transmission and the System X digital exchange.

France's Thomson S.A. group is cementing its own electronics empire with a series of alliances and acquisitions. It has merged its nonmilitary semiconductor business with that of SGS Microelettronica SpA, a member of Italy's STET group. Thomson's president Alain Gomez, a former paratrooper and Harvard graduate

The changing scene across the Atlantic will require U.S. firms to review their strategies to safeguard their own businesses

who two years ago masterminded Thomson's acquisition of Mostek in the U.S., says: "This is the only strategy for survival."

Robert Heikes, cofounder of European Silicon Structures, the fast-turnaround custom chip venture in which half a dozen of Europe's most prominent high-tech firms have invested, says: "It would make sense for Britain's Plessey to make up a semiconductor trio with Thomson and SGS." Thomson officials say there have been contacts with Plessey and do not rule out its entry into the Italo-French partnership.

In passive components, Thomson is cementing its position by turning to Asia. The French group's Thomson-CSF subsidiary has signed up with Daewoo, the South Korean industrial conglomerate, to manufacture soft ferrites. These will be sold to the consumer electronics factories of Philips and America's General Electric Co., as well as those of the two founder partners in Asia.

Earlier this year, Philips and Britain's General Electric Co. merged their medical-electronics imaging businesses to create the biggest diagnostic imaging company in Europe. Now, Thomson has agreed in principle to exchange its assets in medical electronics for those of U.S. General Electric Co. in consumer products. This deal is due to be finalized in November. Thomson has also paid Britain's Thorn-EMI $145.8 million for its television and other electronics brown-goods operations. Thomson's Gomez says: "Consumer electronics will remain, alongside defense and professional electronics, a core business for us. We are now firmly entrenched in the leadership of Europe's consumer products. In fact, we are neck and neck with Philips. Only Matsushita lies ahead of us."

Philips is also reorganizing its world-girdling empire. The Dutch multinational is currently taking over the 42% of North American Philips Corp. that has until now remained outside its control. The buy-out involves such famous U.S. brand names as Genie, Magnavox, Philco and Sylvania. Cornelis van der Klugt, Philips' chairman, comments: "We will now be one unified company and better able to compete on a global basis."

Megaproject

Philips biggest joint venture is Megaproject, a partnership with Siemens AG in developing the semiconductor chips of the future. Almost $1 billion has been invested in this effort by the two companies and by the governments of the Netherlands and West Germany. Philips' mission is to make a one-megabit static random access memory chip, which will have applications in consumer electronics, communications and automobiles. Siemens is developing a 4Mb dynamic random access memory chip which stores four times more information but is slower and consumes less energy.

As it monitors the strategies of competitors such as Philips and Thomson, Siemens is studying new mergers of its own. Last year, the West German giant absorbed GTE Corp.'s U.S. transmission equipment business as well as switch manufacturing units in Italy, Belgium and Taiwan. However, the deal excluded GTE's big switches in the United States. Hermann Franz, group head of Siemens' microelectronics divi-

Europe's version of "Let's make a deal!"

A sampling of recent and planned link-ups involving Europe's electronics companies

Who's doing what...	with whom...	...and why
CGE (France)	**ITT** (U.S.)	A pooling of these companies' telecom activities forms the world's second largest telecom company, Alcatel N.V.
STET (Italy)	**Telefonica** (Spain)	These companies are working together in managing phone networks, introducing new technology and services, and developing telecom standards.
Italtel (Italy)	**Telettra** (Italy)	This joint venture is called Telit. Italtel is STET's public office switching offshoot. Telit is being courted by major European telecom companies such as Ericsson and Siemens.
Thomson (France)	**SGS Microelettronica** (Italy)	This a merger of nonmilitary semiconductor businesses.
Thomson-CSF (France)	**Daewoo** (Korea)	These companies have agreed to manufacture soft ferrites for consumer electronics products.
Philips (Holland)	**GEC** (Britain)	This merger of medical-electronics imaging businesses forms the largest diagnostic imaging company in Europe.
Thomson (France)	**GE** (U.S.)	Thomson's medical-electronics assets are being exchanged for GE's consumer electronics products.
Thomson (France)	**Thorn-EMI** (Britain)	Thomson paid Thorn-EMI $146 million for its TV and other electronics brown-goods operations.
ITT (U.S.)	**STC** (Britain)	ITT is seeking to sell its 23% stake in STC.
Philips (Holland)	**North American Philips** (U.S.)	The Dutch multinational is taking over 42% of the U.S. company that has, until now, remained outside its control.
Philips (Holland)	**Siemens** (W. Germany)	This joint R&D program, called "megaproject," is aimed at developing the chips of the future, including a 4-megabit DRAM. To date, the partners and their national governments have invested almost $1 billion in the project.
Siemens (W. Germany)	**GTE** (U.S.)	Siemens bought GTE's U.S. transmissions equipment business, plus its switch-manufacturing units in Italy, Belgium and Taiwan. The deal excluded GTE's big switches in the U.S.
Ericsson (Sweden)	**Matra** (France)	The two companies have agreed to develop, produce and market new digital phones for a European mobile-telephone network. They are also jointly taking control of former ITT offshoot CGCT.
Groupe Bull (France)	**Honeywell** (U.S.) **NEC** (Japan)	This three-way joint venture forms Honeywell Bull, which is specializing in installing computer networks and selling midsized computer systems serving groups of up to 150 users.
Brown Boveri (Switz.)	**ASEA** (Sweden)	This merger of main operating units forms the world's largest heavy electrical engineering group. The focus is on factory automation, plus planned joint developments in superconductors.

Source: ELECTRONIC BUSINESS

sion, says: "We are constantly asking ourselves whether we have achieved optimal size." Last year, Siemens' sales of semiconductors totalled $360 million, compared with joint sales for Thomson and SGS of $760 million. Franz comments: "Clearly, mergers are a logical strategy." But, although Siemens is frequently approached by potential partners, no serious negotiations appear to be going on at present.

Electronics veteran Heikes, who has run the European semiconductor operations of National Semiconductor Corp. and Motorola Inc., comments: "Siemens does not appear to have a clear strategy in semiconductors at present. They are at a low point in their cycle. With SGS and Thomson now together and Philips faring well on its own, it is difficult to see who in Europe could make up an effective team with Siemens."

Sweden's Ericsson, which has gone head-to-head with Siemens in the contest for public switching orders from America's Bell companies, is also trying to expand its European market. With this target in view, Ericsson has joined forces with Matra, the French electronics and defense group, to take control of Compagnie Générale de Constructions Téléphoniques, an ailing offshoot of ITT which was nationalized five years ago.

The French government's choice of the Ericsson-Matra consortium in a contest against bids from Siemens and a partnership between Philips and AT&T provoked a storm of protests from both the Netherlands and the United States. The deal gives Ericsson immediate access to 16% of the French public switching market, with hopes of a bigger slice later. Ericsson and Matra have also agreed to develop, produce and market new digital phones for a European mobile telephone network.

France is particularly active in restructuring its electronics industry. The gradual return to private ownership of state-managed companies is presenting these with new challenges and opportunities. Groupe Bull, the French flagship computer manufacturer which still awaits privatization, has joined in a three-way joint venture, Honeywell Bull Inc., in which Honeywell Inc. and Bull each hold a 42.5% stake. Japan's NEC Corp., which supplies the two U.S. and French firms with their large mainframes, holds 15%. Within two years, Bull could exercise an option to buy 53% of Honeywell's share in the joint venture.

Based in Minneapolis, Honeywell Bull will specialize in installing computer networks and selling mid-sized systems that serve groups of up to 150 workers. Jacques Stern, chairman of the new venture as well as of Groupe Bull, says: "A $5 billion company with a common strategy and commercial and R&D synergy is a very powerful force." However, industrial observers point out that the venture reflects France's awareness that its computer industry cannot survive without U.S. and Japanese products.

The future of Europe's electronics industry will also be influenced by the recent merger of the main operating units of Brown Boveri & Co. of Switzerland and Asea of Sweden. Together they form the world's biggest heavy electrical engineering group. Both also focus strongly on electronics. And over the past few years, they have become world league forces in factory automation. Percy Barnevik, Asea's president and the designated president of the new company, says: "Factory automation will be one of the major fields of our future development."

Barnevik also intends to embark on a big joint effort to develop superconductors, materials that, at low temperatures, conduct electricity with little or no loss of energy. Brown Boveri Asea will certainly slim down its current workforce of 160,000. But it expects to spend almost $1 billion on research and development and to register sales close to $9 billion.

After the honeymoon-style celebrations of their mergers, companies such as Thomson and SGS are discovering the problems of matrimony. But Europe is also experiencing the end of the era of fragmented markets, which made its manufacturers so vulnerable to competition. This changing scene across the Atlantic will require U.S. firms to review their strategies in order to safeguard their own businesses. ▷

Notes on the top European companies

Electronics sales: Represents ELECTRONIC BUSINESS' estimate of the revenue earned by each company from the sale of electronics products.

The figure shown is based on the latest available completed fiscal year, thus a variety of accounting periods are represented.

Similarly, the electronics sales and other financial information has been converted at the exchange rates at the end of the accounting period.

For European companies, the figure shown is their worldwide sales of electronics products, including those manufactured and sold outside Europe: for non-European companies, the figure estimates their electronics sales in Western Europe only.

Electronics as a percentage of total sales: Indicates the proportion of electronics products within the total consolidated sales of all the products of the company. For firms not European owned, the percentage relates to their electronics sales in Western Europe as a percentage of total consolidated worldwide sales.

Fixed assets per employee: Shows the accumulated value (less depreciation) of land, buildings, plant, machinery, furniture and fittings (including rental equipment) that the company has invested per employee.

Investments as a percentage of sales: Adds together capital expenditures and research and development as a proportion of total consolidated sales.

Return on gross capital employed: Shows profit before taxes as a proportion of net working capital plus fixed assets and investments (for example, equity holdings and other assets, not capital expenditures).

Capital expenditures as a percentage of sales: Shows the amount of new investment in fixed assets during the year as a proportion of total consolidated sales.

Current ratio: Shows current assets as a proportion of current liabilities, giving a rough indication of the liquidity of the company.

Country of origin: Indicates the country in which the company is ultimately registered.

Top companies in Europe – 1986

Rank	Company	Electronics sales ($ millions)	Electronics as a percentage of total sales	Total consolidated sales ($ millions)	Profit before tax as a percentage of sales	Profit after tax as a percentage of sales	Sales per employee	Profit before tax per employee
1	**Philips**	$16,895	67%	$25,131	3.6%	2.1%	$73,013	$2,598
2	**IBM**	16,224	32%	51,250	16.4%	9.3%	127,011	20,790
3	**Siemens**	11,631	50%	23,261	6.5%	3.1%	64,081	4,181
4	**CGE ***	11,500	NM	11,674	3.2%	2.1%	84,484	2,688
5	**Thomson-CSF**	5,610	100%	5,610	7.8%	2.9%	145,901	11,336
6	**GEC**	4,979	59%	8,396	12.7%	8.0%	52,611	6,702
7	**Olivetti**	4,940	91%	5,452	9.8%	7.7%	92,268	9,085
8	**Ericsson**	3,659	78%	4,671	2.9%	1.8%	64,357	1,841
9	**Robert Bosch**	3,409	30%	11,268	6.7%	2.0%	76,456	5,157
10	**Digital Equipment**	3,253	35%	9,389	18.0%	12.1%	84,972	15,284
11	**STET-IRI**	2,840	26%	10,740	7.2%	4.7%	80,812	5,792
12	**Groupe Bull**	2,769	100%	2,769	1.9%	1.5%	103,312	1,917
13	**STC**	2,555	91%	2,823	6.9%	4.5%	74,645	5,181
14	**Rank Xerox**	2,555	26%	9,781	6.9%	5.0%	97,452	6,725
15	**Nixdorf**	2,336	100%	2,336	8.0%	4.9%	91,335	7,333
16	**Hewlett-Packard**	2,197	31%	7,102	11.0%	7.3%	86,610	9,512
17	**Plessey**	2,193	96%	2,288	12.9%	8.4%	71,586	9,223
18	**Racal**	1,902	92%	2,065	7.8%	5.0%	63,708	4,950
19	**Matsushita**	1,900	7%	28,067	9.6%	3.6%	206,555	19,914
20	**AEG**	1,816	31%	5,821	0.6%	0.0%	74,437	472
21	**Grundig**	1,769	100%	1,769	4.9%	3.5%	90,815	4,462
22	**Unisys**	1,750	24%	7,432	-1.2%	-0.6%	75,609	-934
23	**Sony**	1,718	21%	8,180	5.8%	3.2%	168,067	9,690
24	**Canon**	1,516	27%	5,523	3.1%	1.2%	155,589	4,857
25	**NCR**	1,350	28%	4,882	12.7%	6.9%	78,735	9,995
26	**Bayer**	1,238	5%	21,141	8.1%	3.3%	122,201	9,896
27	**Motorola**	1,000	17%	5,888	4.5%	3.3%	62,373	2,807
28	**Schlumberger**	1,000	22%	4,568	NA	-36.2%	91,992	NA
29	**Thorn EMI**	960	19%	5,096	5.0%	3.2%	68,567	3,434
30	**Ferranti**	960	95%	1,006	8.0%	5.0%	46,198	3,689

NA = not available

NM = not meaningful

* ITT's telecommunications activities, acquired on Dec. 30, 1986 are included in electronics sales, but are not included in 1986's consolidated sales. Balance sheet data includes ITT's former subsidiaries consolidated by equity method.

Profit after tax per employee	Fixed assets per employee	Investments as a percentage of sales	Return on gross capital employed	R&D as a percentage of sales	Capital expenditures as a percentage of sales	Current ratio	Fiscal year ended	Country of origin
$1,503	$24,207	15.3%	6.1%	7.6%	7.7%	1.53	12/86	Netherlands
11,868	52,708	19.2%	18.6%	10.2%	9.0%	2.18	12/86	United States
2,009	13,621	22.1%	10.1%	11.5%	10.6%	2.22	9/86	West Germany
1,798	11,571	11.6%	5.4%	6.8%	4.8%	1.29	12/86	France
4,164	29,409	15.7%	21.1%	9.8%	5.9%	1.10	12/86	France
4,214	8,303	4.8%	18.1%	NA	4.8%	2.50	3/87	Britain
7,132	16,928	11.0%	11.7%	5.3%	5.7%	2.24	12/86	Italy
1,145	13,901	15.0%	4.2%	9.9%	5.2%	1.92	12/86	Sweden
1,513	11,670	12.9%	20.9%	5.1%	7.8%	1.34	12/86	West Germany
10,293	19,252	18.7%	26.0%	10.8%	8.0%	3.40	6/87	United States
3,801	169,362	36.1%	3.7%	NA	36.1%	0.83	12/86	Italy
1,573	34,769	22.0%	3.3%	7.7%	14.2%	1.60	12/86	France
3,347	12,293	15.4%	20.3%	8.3%	7.0%	1.61	12/86	Britain
4,862	25,516	17.2%	9.1%	6.6%	10.6%	1.80	12/86	United States
4,511	34,403	23.8%	11.3%	9.5%	14.3%	2.18	12/86	West Germany
6,293	27,268	18.6%	17.2%	11.6%	7.0%	2.51	10/86	United States
5,998	14,621	12.0%	21.5%	6.6%	5.4%	2.17	3/87	Britain
3,178	17,126	5.7%	13.6%	NA	5.7%	1.74	3/87	Britain
7,389	25,318	8.8%	15.7%	5.5%	3.3%	1.79	11/86	Japan
0	10,453	13.0%	1.0%	8.0%	5.0%	2.74	12/86	West Germany
3,194	12,401	9.9%	19.9%	3.4%	6.5%	1.25	3/87	West Germany
-442	22,301	13.4%	-2.3%	5.9%	7.4%	1.36	12/86	United States
5,313	42,186	16.3%	9.6%	9.2%	7.1%	1.55	10/86	Japan
1,877	40,493	15.4%	5.4%	6.2%	9.1%	1.58	12/86	Japan
5,427	15,489	13.6%	23.6%	6.2%	7.4%	2.01	12/86	United States
4,035	29,811	10.9%	17.7%	5.1%	5.8%	1.62	12/86	West Germany
2,055	24,047	18.0%	8.4%	8.4%	9.6%	1.63	12/86	United States
-33,318	36,900	18.3%	NA	8.5%	9.8%	1.64	12/86	Netherlands
2,207	17,563	11.9%	16.0%	1.7%	10.3%	1.11	3/87	Britain
2,315	8,730	5.9%	22.1%	NA	5.9%	1.39	3/87	Britain

Source: ELECTRONIC BUSINESS

DISPLAYS

Electroluminescence lights up in the flat-panel market

They'll hardly replace LCDs entirely. But EL displays are getting glowing reports from makers of laptop computers

Electroluminescence is another one of those "promising" technologies. The technique gives flat-panel displays the bright, crystal-clear images that portable computers have normally lacked, but it is costly and power hungry. At $29 million in world sales this year, EL displays made up only a miniscule portion of the $1.9 billion flat-panel display market, according to market watcher Stanford Resources Inc. But ELs make up the fastest-growing segment, and sales should go over $750 million by the mid-1990s.

Three different technologies are competing for flat-panel dominance, each with its own benefits and foibles. Liquid-crystal displays (LCDs) make up the largest market segment by far, with over $1 billion in 1987 sales. But these are "passive" displays; that is, they only reflect light so they can be difficult to read in poorly lit areas.

Gas plasma displays, which use high electrical current to make a gas glow, are one light-emitting technique; the other is EL, which uses high currents to produce light from a special coating on the screen. Both offer bright contrast, but they suffer from high power consumption — put one on a portable PC and you can forget about running the computer on a battery. Plus, they tend to cost twice as much as LCDs.

"One of the early complaints about laptops was the readability of the LCD. We got hit hard on that," says

> Sales of EL displays should go over $750 million by the mid-1990s

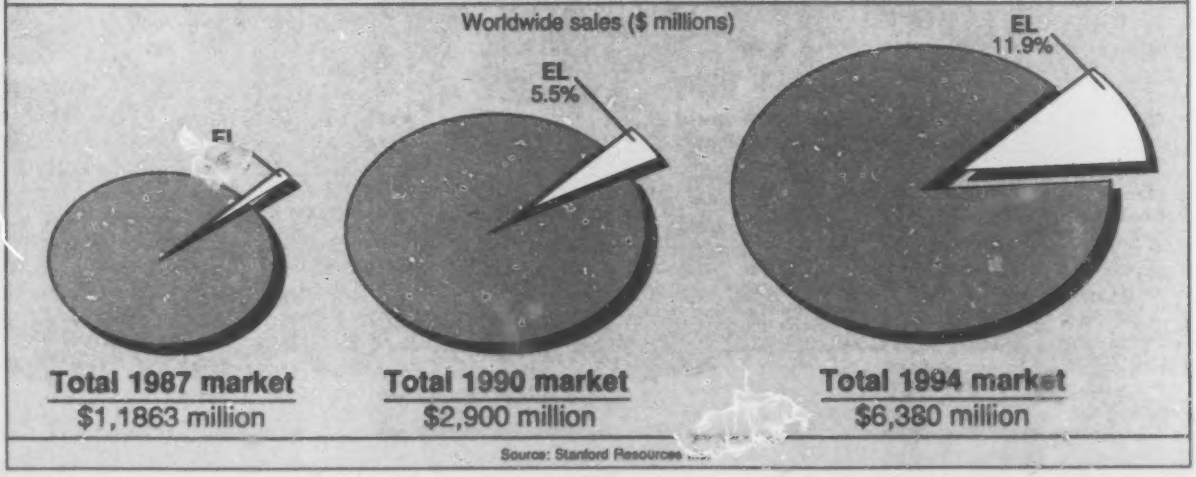
Barbara Nolan, product manager for Data General Corp.'s portables. So DG did a quick redesign a year and a half ago, and offered an EL display from start-up Planar Systems Inc. Nolan says DG looked at plasma — the choice of competitors like Compaq Computer Corp. and Toshiba Corp. — but liked EL's smaller size and lower power consumption.

Although there is a $1,000 price difference between DG's EL and LCD portable computers, Nolan says discriminating customers will swallow the extra expense. A large insurance company, for instance, whose agents have to make presentations to families in their living rooms, appreciates the wide angles of vision EL allows, she says. Still, EL models only make up a quarter of DG's portable sales. "We're happy with that 25%, but in all honesty, it was a little bit higher percentage before LCDs were back-lit," Nolan admits.

Besides putting a light behind the LCD, which adds little to power requirements, LCD makers are fighting back with two types of displays which give high contrast: "supertwist," a new method of assembling the glass layers; and "active matrix" displays, where electronic "driving" of individual picture elements gives superior brightness. "Supertwist won't be the death of EL, but active matrix displays will certainly put a large crimp in the EL marketplace," says David Matthews, national distributor sales manager for Sharp Electronics Corp. of Mahwah, N.J. Sharp makes both EL and LCD screens. Matthews says that the screens of active matrix displays, which so far have shown up primarily in those tiny 3-inch TV sets, will double in size next year.

DG's Nolan thinks that active matrix displays "still will not approach EL" in sharpness. Also, she says, any LCD technology tends to suffer from an "afterimage" effect, which means you can't use it, for example, in oscilloscope functions where the image is constantly moving. Nolan says that the first wave of portable PC buyers

Electroluminescence (EL) begins to shine in the flat-panel market



Source: Stanford Resources

were commercial users, but as technical buyers emerge, applications like instrumentation will take on significance.

Market research firm Stanford Resources gives Planar EL market leadership, by a hair, over Sharp; between them, these two own most of the market. The primary mission of Planar president James Hurd is to drive costs down at his Beaverton, Ore., company. So far, he's slashed the average selling price of his displays 40% a year for the past three years. He attributes much of this to lower component prices — particularly smart-power chips from Texas Instruments Inc. and surface-mounted components in general.

Also, "Planar is ahead of just about everybody" in finetuning its manufacturing process, according to Stanford Resources' researcher Joseph Castellano. Planar, spun off from Tektronix Inc. and partially funded by the instrumentation giant, is

LCD makers are fighting back with two types of displays that give high contrast

achieving near-90% yields on its panels, using a thin-film deposition technique which Hurd says is much like the process technology in the semiconductor industry.

Manufacturing EL displays is no easy task. Delays in starting up its manufacturing line cost Finlux Inc., the U.S. subsidiary of Finland's Lojha Corp., the chance to supply displays for Hewlett-Packard Co.'s portable, says Finlux president Ismo Linden. Instead, Sharp got that business. But Linden remains an HP fan — Finlux makes displays for a touch-screen factory-floor terminal built by HP's Panacom Automation division. Linden says he's looking for a corporate partner to help finance his production ramp-up.

Planar sells displays to its partner, Tek, for audio instrumentation, and also has a solid military business. N.V. Philips GL's Magnavox subsidiary makes a portable datacommunications terminal with a Planar screen, and the Navy plugs one into a Zenith Electronics Corp. PC aboard submarines. Planar also has a $2 million Army contract to develop color EL displays.

DAVID CARD

PERSONAL COMPUTERS

Factory PCs: Training to become better foremen

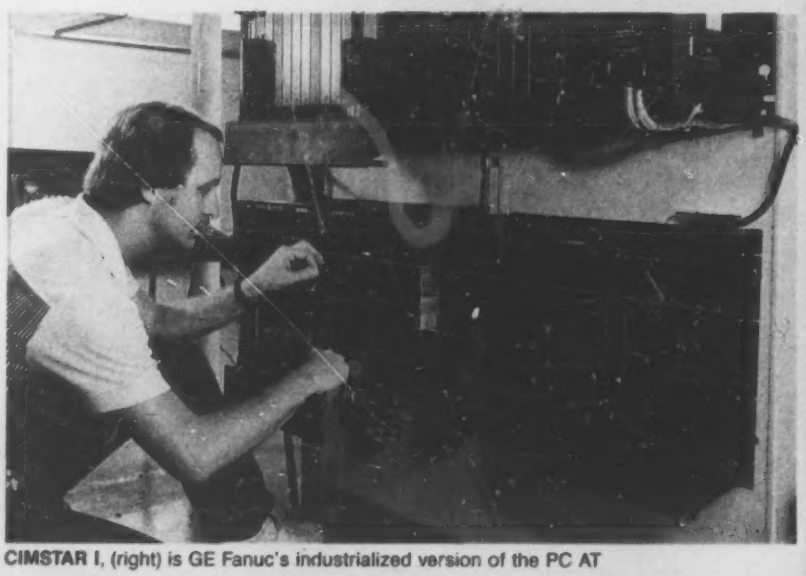
Increasingly, small computers are signing on for industrial control jobs. But don't look for PS/2s on the shop floor yet

Personal computers that are altered and given new model designations for harsh factory floor environments are showing up more and more in industrial control functions. But it's still a small market, possibly less than $15 million worth of shipments this year. And talks with major suppliers suggest it will be some time before IBM's second generation Personal System/2 computer will play a major role in the industrial environment.

"The industrial automation market still is in its infancy," observes Sam Meshulam, PC marketing specialist for Gould Industrial Automation Systems in Andover, Mass. "It's driven by applications, not hardware, so the PS/2 isn't producing a solution." When OS/2, the operating system developed by Microsoft Corp. of Bellevue, Wash., comes around and systems based on the 32-bit Intel 80386 chip proliferate, then "you'll be able to really start doing something, but that won't be for at least another two years," he adds.

Until then, companies that put industrial systems together will continue to use application programs geared toward first generation IBM PC AT and even PC XT applications software. San Diego-based Action Instruments Inc., which is widely acknowledged to have pioneered PCs for use in industrial environments, will introduce an 80386 version of its A-PAC family of industrial PCs in December or January. But it will be compatible with the AT. "It's the safest approach," says president James Pinto, "because the industrial market for PS/2 technology is zero."

Beginning in 1982 with a Z-80 chip version of a personal computer that was "hardened" to resist vibration, higher temperatures and electromagnetic interference environments on the factory floor, Action has brought out computers that were compatible with the XT and AT. Last year it introduced the BC-22, an AT version which is being sold as the Cimstar I by GE Fanuc Automation North America Inc., a subsidiary of a $200 million joint venture between General Electric Co. and Fanuc Ltd. of Japan. Action also sells its BC-22 through an original equipment manu-



CIMSTAR I, (right) is GE Fanuc's industrialized version of the PC AT

REAL ESTATE

Tearing up the "For Sale" sign

As the industry regains its earlier vigor, more and more firms are gradually expanding commercial operations

By Theresa Engstrom

The electronics industry, which has *not* invested heavily in new plants and equipment during the past three years, may be on the verge of a new spending cycle. It may not be the boom of the early 1980s, but it could be a boom, nonetheless.

That's good news for commercial realtors. "The industry has bottomed out, and we are starting to see more activity," says Alan Beaudette, vice president and national director for marketing of industrial products for Coldwell, Banker Commercial Group Inc. Nobody is denying that the past six years have been dark ones: Nationally, since 1980, employment in high-technology companies has increased only slightly more than the national job growth rate of 2.4%, according to Grubb & Ellis, a San Francisco market research firm.

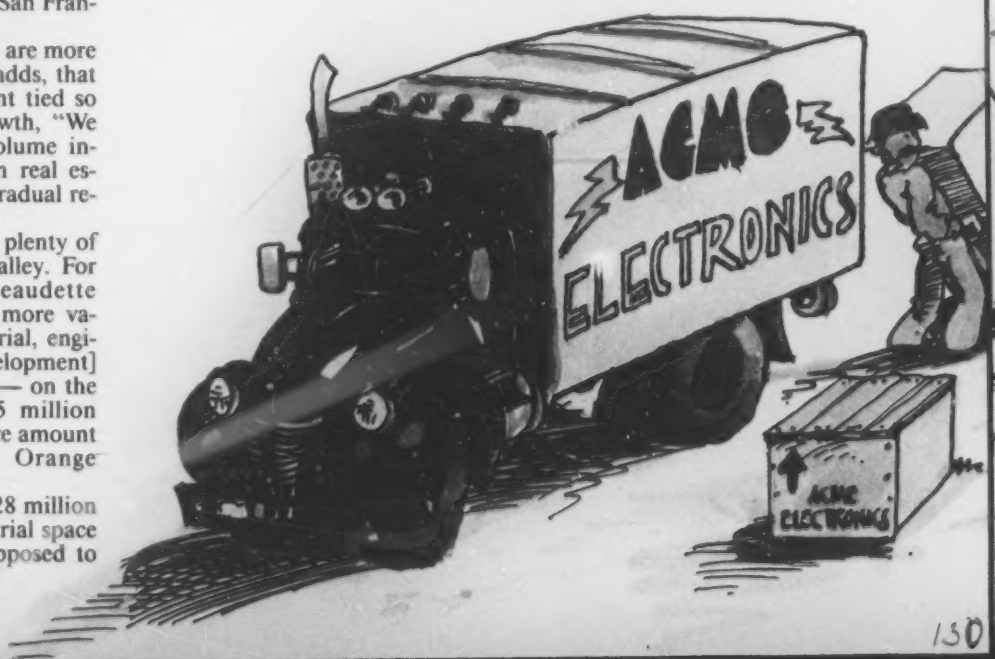
But real estate developers are more optimistic now. Beaudette adds, that with real estate development tied so closely to employment growth, "We won't see a tremendous volume increase [in electronics-driven real estate activity], but rather a gradual rebuilding process."

For starters, there is still plenty of space left in the Silicon Valley. For comparison purposes, Beaudette points out that, "There is more vacant high-tech [light industrial, engineering, research and development] space in the Silicon Valley — on the order of 30 million to 35 million square feet — than the entire amount of high-tech space in Orange County."

The fact that there were 28 million square feet of vacant industrial space in San Jose last July, as opposed to 31 million square feet a year earlier, indicates probable signs of slow rehabilitation. Yet, it also indicates that there is very little new space coming on the market. This may be grim news for developers, but good news to electronics companies, as there are "tremendous deals to be made, all over California," according to one commercial realtor. In some areas, light industrial space is being leased at a 40% less than 1985 prices, says Carl Blanke, senior vice president and branch manager of the San Jose office of Cushman & Wakefield, a commercial real estate firm.

However, the high-tech real estate business is not yet blooming in the Valley. Even where there is hopeful talk of expansion, a closer inspection often shows that contraction, and not expansion, is actually taking place. National Semiconductor Corp., for instance, recently leased two and a half buildings near the San Jose airport. But the move was hardly an expansion; the buildings will be the new home for National's information systems group, which is being brought together under one roof from several other locations. "This sure isn't the time to talk about expansion," a spokesman for the Santa Clara company says.

Outside of northern California, however, it's more difficult to make such blanket statements. At the other end of the country, in New England, some companies have held up well during the recession and show no



Jon McIntosh

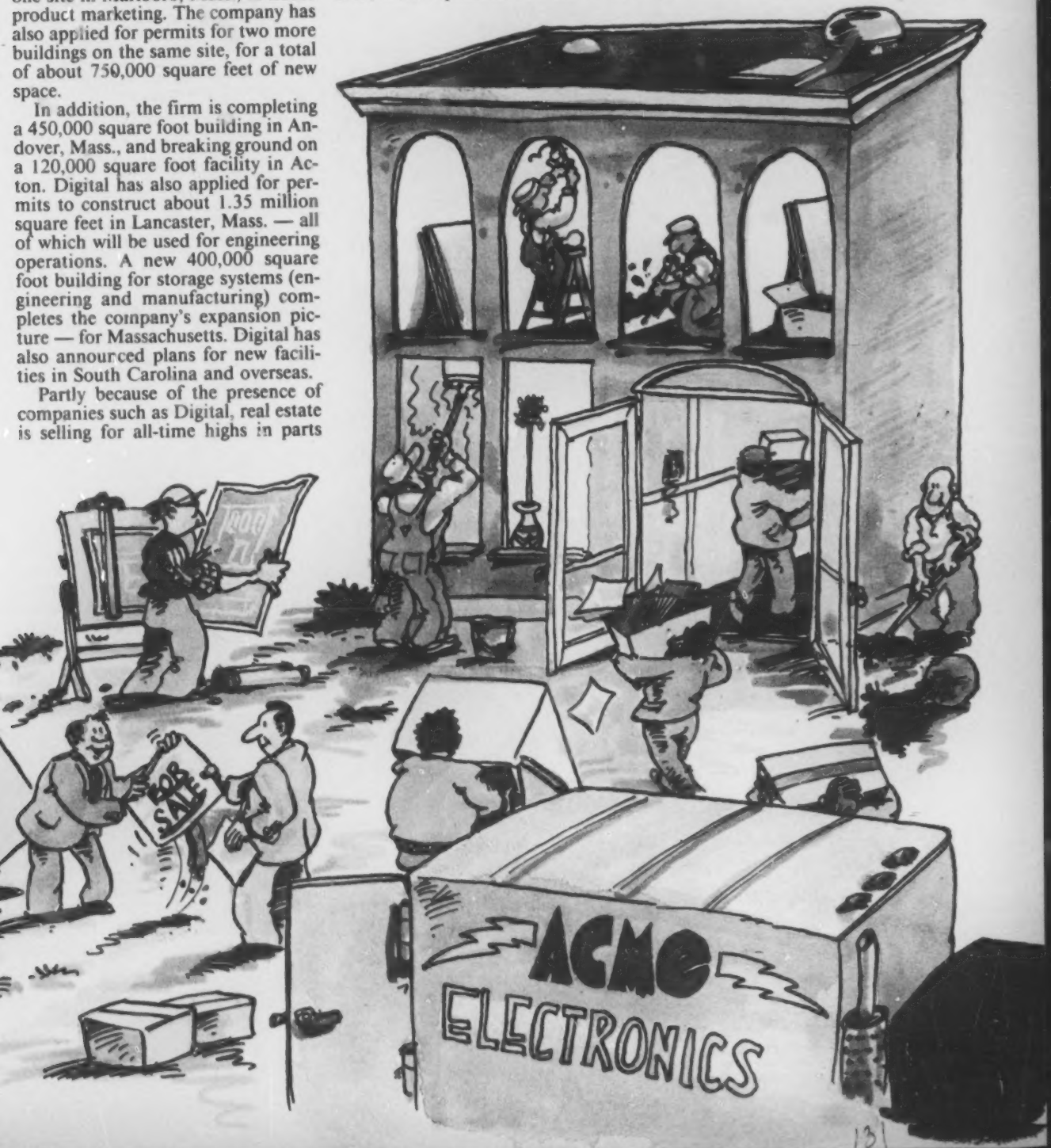
signs of slowing down. In fact, observers of Digital Equipment Corp. might wonder what all the talk of recession is about.

Growth in New England

Digital, which employs about 30% of its 110,000 people in Massachusetts, is building a fourth building on one site in Marlboro, Mass., to house product marketing. The company has also applied for permits for two more buildings on the same site, for a total of about 750,000 square feet of new space.

In addition, the firm is completing a 450,000 square foot building in Andover, Mass., and breaking ground on a 120,000 square foot facility in Acton. Digital has also applied for permits to construct about 1.35 million square feet in Lancaster, Mass. — all of which will be used for engineering operations. A new 400,000 square foot building for storage systems (engineering and manufacturing) completes the company's expansion picture — for Massachusetts. Digital has also announced plans for new facilities in South Carolina and overseas.

Partly because of the presence of companies such as Digital, real estate is selling for all-time highs in parts of New England. Along legendary Route 128, the "technology highway," electronics manufacturers can no longer afford the rates. "It's almost unfeasible to do warehousing or manufacturing on 128," says Brune Levering, vice president and manager of Coldwell Banker's suburban Boston office in Wellesley, Mass. That area, where space now rents for $24 to $28 a square foot, "has matured into a strictly first-class office market," he says. Massachusetts companies are now looking farther afield, along Route 495, some 30 miles outside of Boston, or in southern New Hampshire. "Digital, Raytheon, Prime Computer, Wang Laboratories, Apollo Computer, Sequoia, Proteon and Codex . . ." says Levering,



ticking off a list of Massachusetts electronics companies that are expanding or at least doing well. "The hits just keep coming." New England is certainly not an unqualified success story. But with a 3.1% unemployment rate (as of late summer), it's getting harder to find electronics firms that have fallen on hard times.

East is East

Yet, the difference between East and West is not just an accident of geography; it is more closely tied to the fact that some sectors — such as semiconductors vs. minicomputers — have been harder hit than others. Defense contractors, many of which are concentrated in New England, Southern California, the Pacific Northwest and on the eastern seaboard between New York and Virginia, have been riding an eight-year wave. For them, geography is largely incidental. Ford Aerospace and Communications Corporation, for instance, was awarded $1.7 billion in contracts last year, an increase of $385 million over the previous year. Ford's Western Development Laboratories division recently acquired four buildings in the Golden Triangle Corporate Center near San Jose, a total of 546,000 square feet. The company also bought an adjacent vacant piece of property, which will headquarter the division sometime next year. Western Development Laboratories, a leading designer of communications and weather satellites, has been largely immune to the problems that have afflicted its neighbors in Santa Clara County.

On the other hand, some geographic areas haven't been able to shake off their lethargy, no matter what type of industry they boast. Referring to vacant real estate property, Beaudette says that, "in the oil patch [Texas and Louisiana], there's a tremendous oversupply."

In a recent survey of commercial real estate activity, Grubb & Ellis ranked San Antonio, Texas, last out of 28 metropolitan areas for speculative industrial construction, with an estimated zero percent growth in new building. (Los Angeles was highest, with an estimated 1.9% growth over its existing base, for 7.9 million square feet of new space.)

"Last year when I talked with electronics companies down here, all I got was glassy-eyed stares," drawled one Texas development official, who asked not to be named. "At least this year I think they've blinked once or twice."

Elsewhere around the country, smaller markets are making a name for themselves

Infomart, the big Dallas technology market developed by Trammell Crow, has rented about half of its 880,000 square feet of "leasable" space, according to Michael Weinnig, vice president for corporate systems and services. While he wouldn't say if that figure represented an increase over the year before, Weinnig did say that the mart is "seeing renewed activity." AT&T and Xerox Corp., two of Infomart's tenants, have either expanded recently or are exploring the possibility, says Weinnig.

Elsewhere around the country, smaller markets are making a name for themselves. Last year, the greater Washington, D.C., area — not traditionally considered an electronics mecca — employed 13,000 people in the computer industry, and 34,000 in "high tech," according to Grubb & Ellis. (The firm defines high tech as any industry with above average R&D spending; above average proportion of technical, engineering and/or scientific jobs; above average growth in manufacturing employment since 1980; significant industry employment in multiple locations; industry primarily making product, not just using product; and with a product cycle less than 15 years old.)

Partly because of its smaller base (34,000 employed in "high tech," compared with 234,000 similarly employed in San Jose), Washington, D.C. experienced the fastest high-tech employment growth rate among 28 major metropolitan areas, an 11.6% increase between 1980 and 1986, according to Grubb & Ellis.

Rate pressure

While this has encouraged investment in industrial space, it has also put some upward pressure on rates. Last year, rental rates of $9 per square foot weren't unusual in Washington for warehouse and manufacturing space; $12 was common for research and development facilities (compared with the $4 price found in many other areas).

"We don't see an oversupply in D.C.," says Beaudette, who allows that "most major electronics companies have a presence in that area." Part of the attraction, he adds, is the perceived "quality of life," as well as a good transportation network, a wealth of blue- and white-collar labor, and proximity to the European market via the eastern seaboard.

Another name that crops up frequently is Florida. Downtown Boca Raton is a boomtown, with many smaller firms swimming around the anchor, IBM. Both Tampa and Orlando are considered "emerging centers," as are other sites around the country, such as northern New Jersey; Colorado Springs; Salt Lake City; and the desert cities of Albuquerque,

How much is high tech?

The numbers tell the story: In Santa Clara County and its surrounding environs, "high tech" absorbed about 11.5 million square feet of space in 1985; that figure rose to 12.9 million in 1986; and for the first half of 1987, it was looking still healthier at 7 million square feet, according to figures compiled by Cushman & Wakefield of California.

And the major markets — which Beaudette identifies as Southern California, suburban Boston and Washington, D.C. — are doing fine, thank you.

"It won't be a slam-dunk recovery," says Beaudette. But electronics companies who are starting to think again about expansion after the long dry spell will find a plentiful amount of space and soft prices await them when they finally do make their move. □

N.M., and Tucson, Ariz.

"Raw materials used to be an important factor in a company's decision to locate somewhere," says Beaudette. "But today the quality and type of labor is much more important."

Labor, in fact, has given rise to the "maquiladora" (Spanish for twin plants) phenomenon, whereby a company locates one plant on the Mexican side of the border and a sister plant on the American side. Manufacturing is conducted on the Mexican side, to take advantage of an effective labor rate of about $1.10 per hour; final assembly takes place in the United States, so the product can bear the "Made in USA" label.

> Some geographic areas haven't been able to shake off their lethargy, no matter what type of industry they boast

Sanyo and Ford make up just two of the 800-plus maqui companies, says Beaudette. "The cost of the physical plant is about the same in the United States and Mexico," he says. "But the cost of the facility is relatively insignificant compared with the cost of labor. That's the big ticket."

However, financing also plays a part in companies' expansion decisions, and the political climate hasn't been kind to industrial development. Investment in industrial development bonds slowed to a crawl when it was feared that Congress would kill all bond-related tax exemptions, says Don Backstrom, executive director of the California Industrial Development Financing Advisory Commission in Los Angeles. In its final form, the Tax Reform Act disallowed tax-exempt bonds for commercial, retail and warehouse space, but kept tax-exempt status for manufacturing space. It also imposed a $10 million per project limit on tax exempts.

"Any electronics firm with manufacturing applications can still take advantage of tax-exempt bonds," says Stephen Hamill, chief executive of financial advising firm H.B. Capital Resources Ltd. of Pleasanton, Calif. "The message is: Bonds are alive and well."

However, the state of the economy in California and confusion over the bonds status dampened investor enthusiasm last year, at least in California. "This year has been pretty doggone slow," says Backstrom. However, he says investors are "coming back to the table" now that the tax implications are better understood. Backstrom's agency expects to reach its cap of $350 million next year (up from $250 million). Last year, the agency sold only $150 million worth of bonds.

Yet, as important as financing and quality of life may be, they pale beside the culture and economy that have taken decades to develop in the Silicon Valley. And for that area, the outlook — while not overwhelmingly positive — is slightly rosier than it was last year, which bodes well for the industry as a whole. ▷

Top 15 high-tech employment growth centers

Metro area	1986 employment (thousands)	Total job change 1980-1986 (thousands)	Average annual change 1980-1986 (percentage)
San Jose, Calif.	234	49.8	4.5%
Boston, Mass.	175	36.9	4.4%
Los Angeles, Calif.	297	25.6	1.6%
Dallas, Texas	96	22.5	5.1%
Phoenix, Ariz.	69	17.7	5.8%
Anaheim, Calif.	114	17.3	3.0%
Seattle, Wash.	101	16.7	3.3%
Washington, D.C.	34	14.0	11.6%
Atlanta, Ga.	35	9.8	6.5%
Nassau-Suffolk, N.Y.	85	9.6	2.1%
San Diego, Calif.	64	9.4	2.8%
Philadelphia, Pa.	66	8.9	2.6%
Tampa, Fla.	23	8.4	9.3%
Minneapolis, Minn.	58	8.3	2.8%
Ventura-Santa Barbara, Calif.	30	7.8	5.9%
National total	3,731	457	2.3%

Source: Grubb & Ellis Research Services, U.S. Department of Commerce, Bureau of Labor Statistics

NORTHEAST

Connecticut

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Maine

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Massachusetts

Business conditions

Total electronics workforce 120,300

Average hourly wage (production line) $9.72

Average annual salary for electrical engineers . . . . . .$26,700-$40,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 15

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New Hampshire

Business conditions

Total electronics workforce 25,052

Average hourly wage (production line) $10.45

Average hourly wage (clerical) $7.51

Average annual salary for electrical engineers $22,000

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New Jersey

Business conditions

Total electronics workforce 180,265

Average hourly wage (production line) $8.00

Average hourly wage (clerical) $5.25

Average annual salary for electrical engineers $35,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 4

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New York

Business conditions

Total electronics workforce 154,300

Average hourly wage (production line) $9.92

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects: EE = 21; computer science and other = 72

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Pennsylvania

Business conditions

Total electronics workforce 98,100

Average hourly wage (production line) $9.74

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 41

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Rhode Island

Business conditions

Total electronics workforce 20,000 (manufacturing)

Average hourly wage (production line) $8.25

Average hourly wage (clerical) $6.00

Average annual salary for electrical engineers $40,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 2

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Vermont

Business conditions

Total electronics workforce 12,100

Average hourly wage (production line) $6.22

Average hourly wage (clerical) $5.68

Average annual salary for electrical engineers $34,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 1

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ATLANTIC

Delaware

Business conditions

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Florida

Business conditions

Total electronics workforce 76,451

Average hourly wage (production line) $4.35

Average hourly wage (clerical) $4.87

Average annual salary for electrical engineers $24,100

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 8

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Georgia

Business conditions

Total electronics workforce 31,922 (manufacturing)

Average hourly wage (production line) $8.34

Average hourly wage (clerical) $6.92

Average annual salary for electrical engineers $41,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 1

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Maryland

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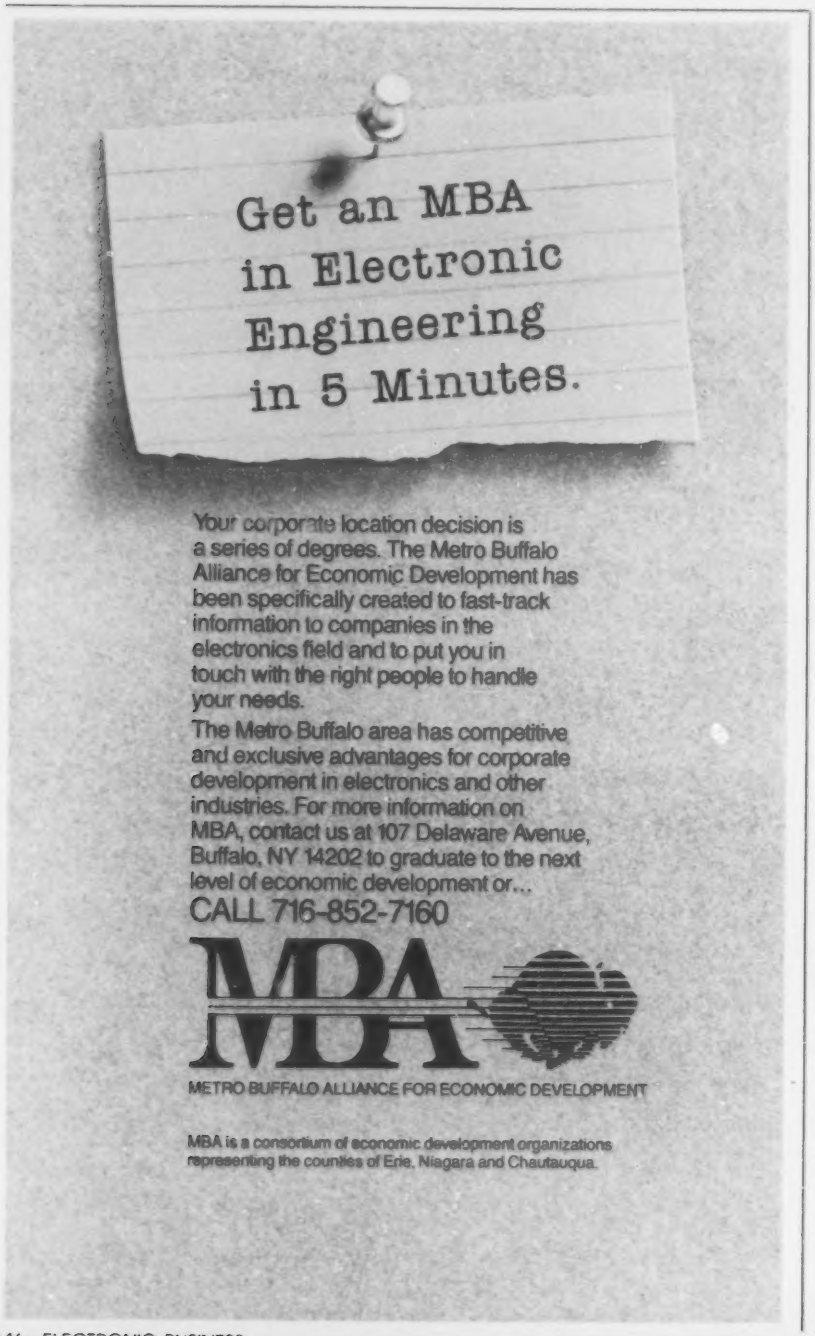
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North Carolina

Business conditions

Total electronics workforce 61,000

Average hourly wage (production line) $8.92

Average hourly wage (clerical) $6.87

Average annual salary for electrical engineers $28,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 5

Additional information

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South Carolina

Business conditions

Total electronics workforce 45,000

Average hourly wage (production line) $8.08

Average hourly wage (clerical) $6.35

Average annual salary for electrical engineers . . . . . .$28,000-$45,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 2

Additional information

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Virginia

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West Virginia

Business conditions

Total electronics workforce 2,700

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 1

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Kentucky

Business conditions
Total electronics workforce 5,000
Average hourly wage (production line) $10.09
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 3

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Mississippi

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Oklahoma

Business conditions
Total electronics workforce 14,500
Average hourly wage (production line) $10.42
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 3

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MIDWEST

Illinois
Business conditions
Total electronics workforce 123,100
Average hourly wage (production line) $20.57
Average hourly wage (clerical) $9.46
Average annual salary for electrical engineers $34,000
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 186
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Kansas
Business conditions
Total electronics workforce 9,500
Average hourly wage (production line) $6.40
Average hourly wage (clerical) $6.50
Average annual salary for electrical engineers $27,000
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 3
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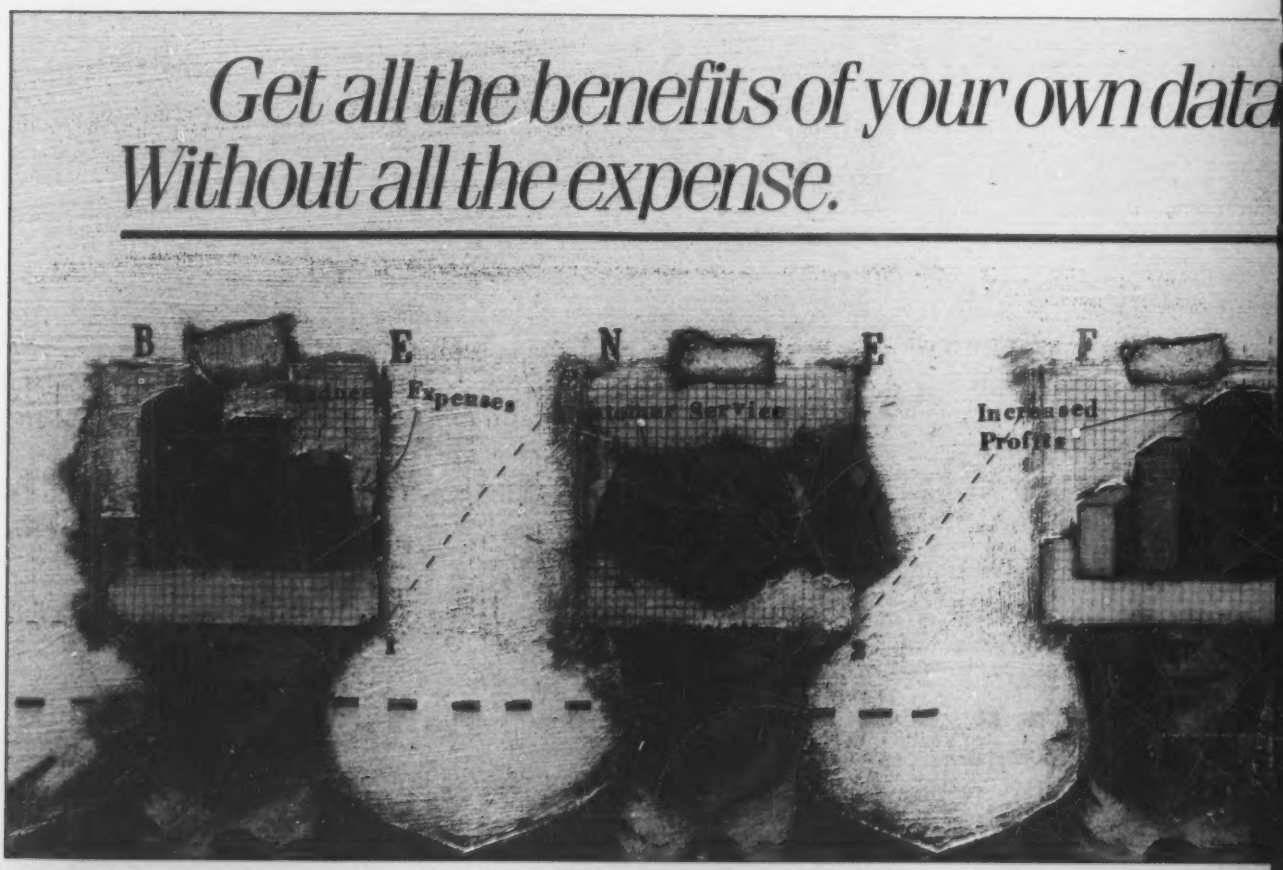
Iowa
Business conditions
Total electronics workforce 10,850
Average hourly wage (production line) $10.32
Average annual salary for electrical engineers . . . . . .$27,738-$34,736
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 5
Additional information



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Missouri

Business conditions

Total electronics workforce 82,000

Average hourly wage (production line) $9.73

Average hourly wage (clerical) $6.30

Average annual salary for electrical engineers $30,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 52

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Nebraska

Business conditions

Total electronics workforce 8,258

Average hourly wage (production line) $9.28

Average hourly wage (clerical) $4.67

Average annual salary for electrical engineers $50,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 2

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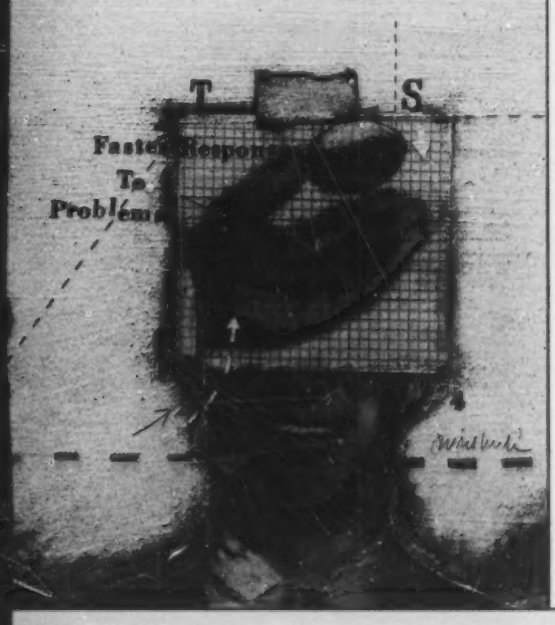

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New Mexico
Business conditions
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 4
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Oregon
Business conditions
Total electronics workforce 44,300
Average hourly wage (production line) $4.34
Average hourly wage (clerical) $4.37
Average annual salary for electrical engineers . . . . . .$27,000 (entry level)
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 15
Additional information
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Washington
Business conditions
Total electronics workforce 148,698
Average hourly wage (production line) $7.56
Average hourly wage (clerical) $5.84
Average annual salary for electrical engineers $26,500
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 12
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